August 10, 1959

Aviation Week

Including Space Technology

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- Lycoming T55
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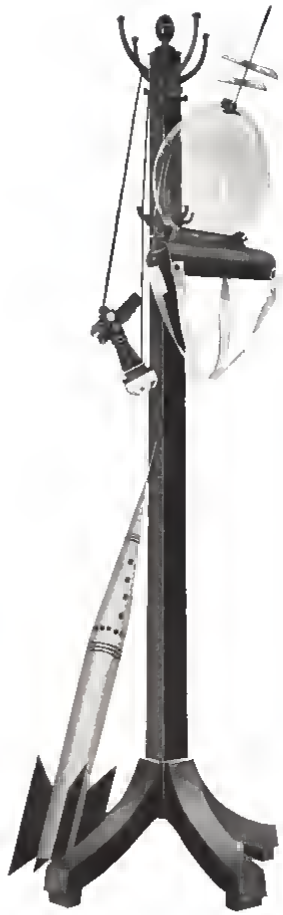

SOME DOWN-TO-EARTH THOUGHTS ABOUT THE SPACE AGE

Like all those who participate in the progress of aviation, we are awed by the prospect of the conquest of space. But before we rush headlong into the cosmic dust, let's hang up our space helmets for a moment for some sober reflection on what it will take to get there.

In the race toward tomorrow, look to the reliable as well as the swift. Our recent missile successes and "failures" clearly indicate that space conquest will depend not only on technological *breakthroughs*, but equally on the virtual elimination of mechanical *breakdowns*. Good hardware is even more important in the space age.

For over 16 years, Hydro-Aire has built a reputation on building better hardware for airborne vehicles. Today these products function reliably on virtually every type of aircraft. The same ingenuity and dependability that made these products possible is now the key to solving the problems of more hostile environments, more stringent operating conditions.

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AVIATION CALENDAR

Aug 16-17—Annual Reunion, the Early Birds, Lakefront Airport Cleveland Ohio

Aug 17—First National Ultrasonic Symposium, Institute of Radio Engineers Professional Group on Ultrasonics Engineering, Stanford University, Stanford, Calif

Aug 18-21—Western Electronic Show & Convention, Institute of Radio Engineers Cow Palace, San Francisco Calif

Aug 23—Downtown Baton Rouge Exchange Club's Sky O Rama, Baton Rouge La Program includes the Blue Angels and military displays, both flying and static

Aug 24-26—Gas Dynamics Symposium American Rocket Society, Northwestern University, Evanston, Ill

Aug 24-26—Institute of the Aeronautical Sciences National Specialists Meeting a symposium on anti-submarine warfare, (classified) San Diego, Calif

Aug 24-27—Fourth Symposium on Ballistic Missile and Space Technology, Los Angeles, Calif Sponsors USAF's Ballistic Missile Division, Space Technology Laboratories, Inc

Aug. 27-28—International Commonwealth Spaceflight Symposium, Church House, Westminster, London England

Aug 31-Sept 2—Annual Army-Navy Instrumentation Program (ANIP) Symposium and Industry Briefing Statler Hilton Hotel Dallas, Tex

Aug 31-Sept 3—Conference on Stratospheric Meteorology American Meteorological Society, Curtis Hotel, Minneapolis, Minn

Aug 31-Sept 5—10th Annual Congress International Astronautical Federation, Church House Westminster, London

Sept 1-2—Conference on physical chemistry in aerodynamic and space flight University of Pennsylvania, Philadelphia, Pa Sponsors Air Force Office of Scientific Research and General Electric Co's Missile and Space Vehicle Dept

Sept 2-4—1959 Cryogenic Engineering Con-

(Continued on page 6)

AVIATION WEEK Including Space Technology

August 10, 1959

Vol 71, No 6

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AVIATION CALENDAR

(Continued from page 5)

ference, University of California, Berkeley, Calif.

Sept. 3-6—National Convention and Aerospace Panorama, Air Force Assn., Exhibition Hall, Miami Beach, Fla.

Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

Sept. 9-11—Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Tex. Sponsors: AFOSR/Directorate of Aeronautical Sciences, Office of Naval Research, National Science Foundation.

Sept. 14-15—Display of USAF Ground Support Equipment for Manned and Unmanned Aerospace Vehicles, Society of Automotive Engineers, Milwaukee Arena, Milwaukee, Wis.

Sept. 14-16—14th Midwest Quality Control Conference, American Society for Quality Control, Sheraton Hotel, French Lick, Ind.

Sept. 16-17—Western Regional Meeting on Frontiers of Science and Engineering, Institute of the Aeronautical Sciences, Los Angeles, Calif.

Sept. 17-18—Conference on Effects of Nuclear Radiation on Semiconductors, Western Union Auditorium, New York, N. Y. Sponsor: Army Signal Corps.

Sept. 20-25—14th Annual Conference and Exhibit, Instrument Society of America, Chicago Amphitheater, Chicago, Ill.

Sept. 21-22—Conference on Planning and Designing of Urban Helicopter Facilities, Institute of Aeronautical Sciences Bldg., Los Angeles, Calif. Sponsor: Los Angeles Chamber of Commerce.

Sept. 21-22—Eighth Annual Meeting, Standards Engineering Society, on Investment in Survival, Somerset Hotel, Boston, Mass.

Sept. 23-24—Engine and Operations Symposium, Airwork Corp., Millville, N. J.

Sept. 28-30—1959 National Symposium on Telemetering, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif. Sponsor: Institute of Radio Engineers, Professional Group on Space Electronics & Telemetry.

Sept. 30-Oct. 2—13th Annual Meeting, Southeastern Airport Managers' Assn., Washington Duke Hotel, Durham, N. C.

Oct. 5-7—Seventh Anglo American Aeronautical Conference, Institute of the Aeronautical Sciences, Hotel Astor, New York.

Oct. 5-10—National Aeronautic Meeting, Society of Automotive Engineers, the Ambassador, Los Angeles, Calif.

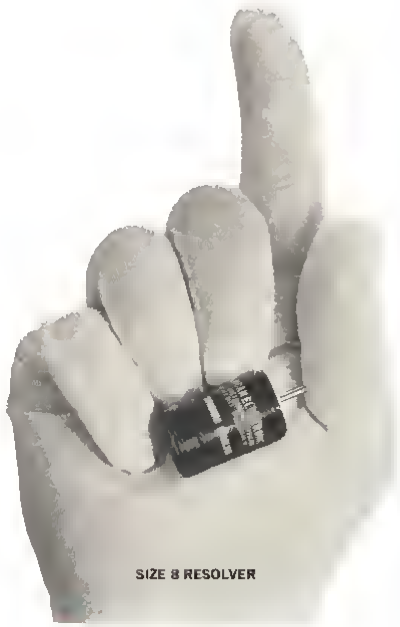
Oct. 6-8—12th Annual Meeting, National Business Aircraft Assn., Hotel Leamington, Minneapolis, Minn.

Oct. 6-9—International Symposium on High Temperature Technology, Asilomar Conference Grounds, Monterey Peninsula, Calif. Sponsor: Stanford Research Institute.

Oct. 8-10—Society of Experimental Test Pilots Symposium on Pilot's Role in Space Exploration, Beverly Hilton Hotel, Beverly Hills, Calif. Third Annual Awards Banquet, Oct. 10.

Oct. 12-14—15th National Electronics Conference, Hotel Sherman, Chicago, Ill.

Oct. 12-16—15th General Convention of the International Air Transport Assn., Tokyo, Japan.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SIZE 8 SERVO MOTOR


SIZE 8 MOTOR TACHOMETER

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SIZE 8 RESOLVER—The first winding-compensated Size 8 in the field* Maximum functional error 0.1% (accuracy). Null voltage does not exceed 1 millivolt per volt input Available with BuOrd type shaft.

	IRHN4-R00	IR6N4-501	*IPRW4-502
Maximum Input Voltage	26	26	26
Effective Resistance (Ohms)	1180	5787	340
Input Impedance (Ohms)	130+j370	487+j1580	220+j370
Total Null Volt (MV/V Input)	1 mv/v	1 mv/v	1 mv/v
Maximum Functional Error (%)	1	1	.1
Transformation Ratio (Degrees)			
Rotor to Stator	.94±.02	47±.02	.87 .02
Rotor to Compensator	——	——	.59 .02

SIZE 8 STEPPER MOTOR—Stepping rate up to 120 pulses per second Low rotor inertia enables unit to be high speed type

FEATURES

1. High reliability, no mechanical detent.
2. Precision stainless steel ball bearings for long life with no radial play
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4. No brushes to wear out

Stepping Rate (Pulses per second)	80
Torque (in. oz.) at SR*	0.9 in oz
Rotor Inertia (Gm Cm²)	7
Voltage	28 volts
Current	260
Temperature Range (Degrees C)	−55° to +100°

SIZE 8 SERVO MOTOR—Available with stall torque up to 42 in oz Max. weight 1.5 ounces

No Load Speed (RPM)	9500
Stall Torque (in -oz.)	0.33
Rotor Inertia (Gm Cm²)	0.75
Acceleration at Stall (rad/sec²)	31,000
Temperature Range (Degrees C)	−55° to +125°

	FIXED PHASE	CONTROL PHASE Series	CONTROL PHASE Parallel
Voltage	26	26	13
Frequency (CPS)	400	400	400
Power Input (Watts)	3.0	3.0	3.0

SIZE 8 MOTOR TACHOMETER—Units have high (100°C) and low (−55°C) temperature range Fixed Phase Voltage 26V

MOTOR

No Load Speed (RPM)	9,000
Stall Torque (In. oz.)	0.25
Rotor Inertia (Gm Cm²)	1.0
Acceleration at Stall (Rad/Sec²)	17,500
Temp. Range (Deg. C)	−55° to +85°

TACHOMETER

Reference Voltage	26
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Output Voltage (volts/1000 RPM)	.3
Null Voltage (volts)	.012

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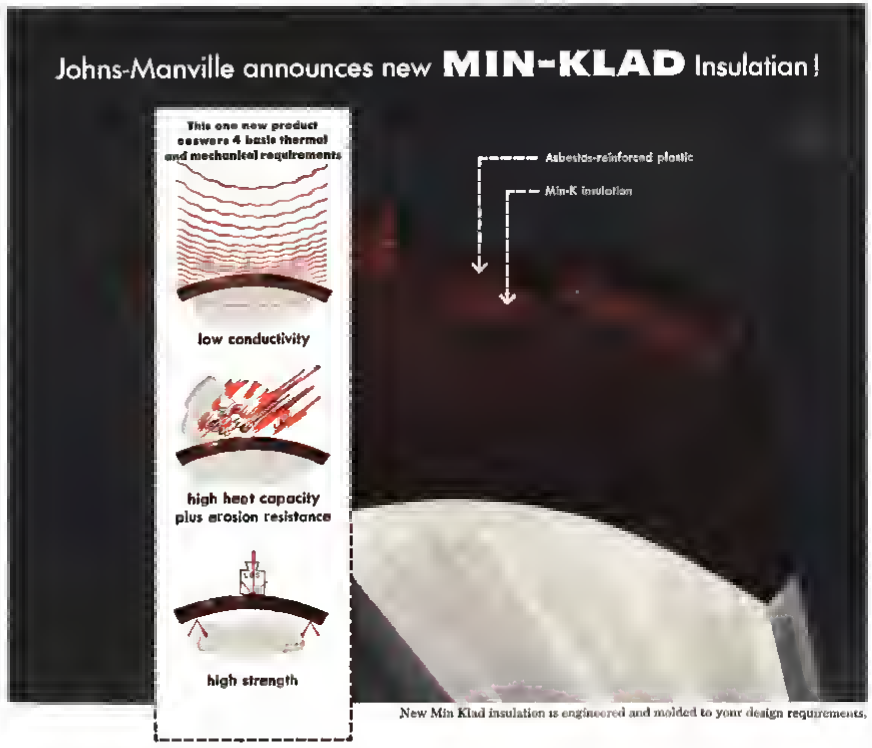

Combines the capabilities of asbestos-reinforced plastic with the dramatically low conductivity of MIN-K insulation!

New Min-Klad insulation may well be the most significant advance ever made in missile and rocket insulation.

Developed by Johns-Manville research scientists, Min-Klad is the only product of its kind, a permanent lamination of the missile industry's two most effective high-temperature materials: 1) reinforced plastic and 2) J-M's recently developed Min-K insulation.

Does more than plastic alone

Min-Klad gives the missile designer all the advantages of high-temperature plastic. Strength, toughness, rigidity! Erosion resistance! High heat capacity! Yet Min-Klad does more.

It also insulates ... and with dramatic effectiveness! Its insulating element is J-M's Min-K, an insulation with thermal conductivity that is actually lower than the molecular conductivity of still air. And this conductivity (already less than half that of the best fibrous insulations) drops still further with altitude. At 10 miles, for example, it is decreased by as much as 40%, with further decreases at greater altitudes.

Wide range of applications

Min-Klad offers the missile and rocket designer a rich choice of heat-control possibilities. It may be used for a part that must insulate, yet have the structural advantages of plastic. Where requirements call for a scuff- and erosion-resistant insulating surface ... or for a good adhesive bond between Min-K insulation and other surfaces. Or, it may be used to control high transient temperatures! For high heat capacity of asbestos-reinforced plastic combined with the low conductivity and heat capacity of Min-K result in a product that provides minimum heat transfer under transient conditions.

Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

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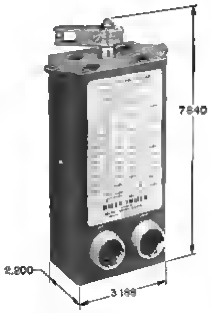
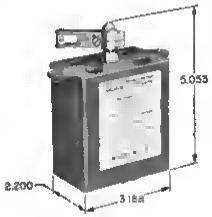
Multiple switch assemblies for aircraft applications



Series "2EK" 20-pole switch assembly



Series "1EK" 5-pole switch assembly

MICRO SWITCH not only offers aircraft designers precision switches of the utmost dependability . . . but provides them in compact assemblies to meet specific multiple circuit requirements.

The "EK" Series, two of which are shown here, is typical of this MICRO SWITCH skill in providing a complete package ready to install.

These "EK" assemblies, one a 20-pole and the other a 5-pole, have proved invaluable in aircraft armament applications. They are compactly wired to standard connectors. Circuits are plainly marked, and the assembly sealed in an environment-proof housing. Switch assemblies shown are operated by positive-drive, non-spring return rotary levers. These assemblies have close-tolerance on-off action. Height of the larger 20-pole switch is only 7.840" which permits mounting in small space.

MICRO SWITCH has developed a large number of switch assemblies to meet specific aircraft design problems. If one of those now available does not solve your multiple circuit problems, our engineers and technicians have the skill and experience to develop an assembly for your need. Save time. Save money. Consult MICRO SWITCH.

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Like magic, the new Voodoo F-101B streaks to its target with an amazing combination of speed and long range. Such outstanding performance demands dependable operating temperatures *every second*. That's why rugged and reliable Harrison heat exchangers were selected to cool the engine oil on this supersonic all-weather interceptor of the Air Defense Command. Built and backed by General Motors, Harrison heat-transfer equipment provides dependable temperature control—in every type of industry, every line of defense. Harrison, with over 47 years in the heat-exchanger field, is your assurance of top quality in product and performance. If you have a cooling problem, look to Harrison for the answer.

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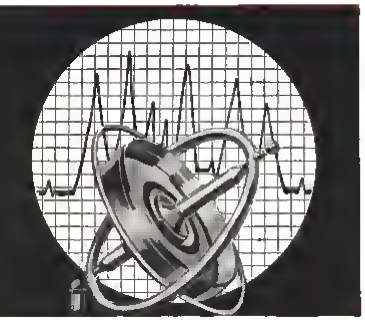

b

c

d

a. Titanium slabs are heated prior to rolling into continuous sheet coils. Crucible's increased capacity for producing high purity metals, in all sizes and mill forms, is substantially reducing costs and delivery times.

b. Vacuum Melted Alloys are specified for gyroscope balls used in navigational and fire direction systems. The metals' improved properties facilitate miniaturization.

c. Titanium helium storage bottles for ICBM Atlas. Titanium, which must be vacuum melted, was selected because of its high strength weight ratio, cold-resistant properties and corrosion resistance.

d. Basic Melting Processes. Vacuum induction melting produces "purer" metals than conventional air melting because it eliminates all sources of contamination except the crucible. Vacuum arc remelting eliminates the crucible and permits production of ingots up to 18,000 lbs.

a

VACUUM MELTING CREATES SUPER-DUTY METALS

Marked improvements in properties produced by High-Purity Metallurgy

Behind the development of space age metals with entirely new characteristics is vacuum melting — a series of processes that produce "purer" metals with better properties.

Why Vacuum Melt? Vacuum melting protects molten metal from contact with air. It also provides closer control of composition, helps eliminate inclusions, and minimizes center porosity and segregation in ingots.

In the field of vacuum melting, Crucible's position is unique. As the leading producer of special purpose steels, Crucible's experience in high-quality steelmaking is unsurpassed. Through formerly affiliated companies, now fully integrated with it, Crucible led in the development and commercial production of vacuum melted steels, iron, nickel, copper — and titanium. Therefore, Crucible's breadth of experience, together with its extensive facilities, places the company in the best position to provide the "super-quality" metals most suitable for any given application.

The three vacuum-melting processes — One of the Crucible processes is VIM — *vacuum induction melting*. It starts with very high-purity raw materials, produces extremely pure ingots. A second is VAR — *vacuum arc remelting*, or the consumable electrode process. This process, starting with air-melted electrodes, produces large ingots — up to 32" diameter x 18,000 lbs. It provides metal with low-gas content and greatly improved uniformity of properties. The third process is VIR — *vacuum arc remelting of vacuum induction melted electrodes*—a double-melting technique. It permits manufacture of super-pure metals in the full range of ingot sizes.

Crucible's experience with all three processes, and its facilities for vacuum arc remelting its own specially air- or vacuum-melted electrodes, provides industry with a complete range of vacuum-melted metals at the lowest possible cost. Only at Crucible is there available this experience, flexibility and the facilities for vacuum-melting titanium, super-alloys, heat-resisting alloys, bearing steels, tool steels, stainless steels, electronic alloys and nuclear reactor materials.

If you'd like to know more about Crucible's work in High-Purity Metallurgy, read: "Quality Aspects and Properties of Vacuum Induction Melted and Vacuum Arc Remelted Steels and Super Alloys" and "Titanium for Aircraft and Spacecraft". Write: *Crucible Steel Company of America, Dept. AH-17, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

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COVER: Sun is shown a few degrees above the horizon during the ascending portion of a 1,500 mi. flight by a Douglas Air Force Thor intermediate range ballistic missile nose cone. The re-entry vehicle, designed by General Electric's Missile and Space Department, was the first to be stabilized around all three axes and to utilize all of the basic elements of an interplanetary flight control system. Two infrared sensors were used for yaw and pitch stabilization so that the nose cone would be stable to the horizon and held around local vertical. Roll stabilization was accomplished with a sun tracker. Camera lens gives the sun a sparkling appearance and reflections from lens elements produce small circles of light on the photo. For other pictures, see p. 32.

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Facing Soviet Facts

(Frank Holeman of the New York Daily News is an able veteran of the Washington press corps who accompanied Vice President Nixon on his recent tour of the Soviet Union and Poland. In this dispatch to the Daily News, written on his return to the United States, Holeman presents a fresh and vivid picture of the impact of the 1959 vintage Soviet Union on an American citizen. Our own experience in the Soviet Union in 1956 and again two months ago confirms the accuracy of Holeman's observations. We are reprinting his dispatch below because it is a story every American should read and heed.—R. B. H.)

We waved good by to a lot of friendly people in Warsaw, Poland, this morning on the way to the airport with Vice President Nixon.

They laughed and clapped and some threw bunches of carnations and gladioli.

Here and there along the way, though, you'd see a man or a woman wave, smile, then suddenly turn sad. I saw one man wiping his eyes after we passed.

There was really something pathetic about the whole episode. In 12 hours with our big jet transport planes, we would be in a different world, the free world. The poor Poles would still be right there in the Communist world, which many obviously detest.

Two Week Lifetime

We learned a lot of new things about that Communist world in our two weeks with Nixon. It may not sound like a long time to you, but two weeks behind the Iron Curtain can be a lifetime.

The Russians gave us the most extensive tour of their country any big group of Westerners has ever had. Granted that we saw only the cities and factories they selected, we still saw more than anybody else.

Impressions differ, of course. Here are the very strong convictions I brought back:

1. We have badly underestimated Russia, particularly its vigorous economic growth.

2. Prime Minister Khrushchev is so cocky over Russia's recent achievements and potential expansion that he underestimates us, too. That's the real reason for his being invited to the U.S.

3. President Eisenhower was dead right when he said we can lose the struggle between free enterprise and a managed economy—and thus lose our freedom—unless all groups in the U.S. begin to exercise a lot of self discipline.

4. Worse than that, we can lose the economic and political hold if we keep raising prices. We can become a second class power while we're gaily paying each other higher prices and wages unrelated to the real cost of production. In a few years, the Communists will be flooding world markets at rock-bottom prices, or below.

5. As much as anything else, we need to reawaken our deep national pride, which seems to sleep between wars. Many Russians have enthusiasm for their way of life, believe it or not. All over the country are signs, "Work for the Victory of Communism!" We need the same kind of enthusiasm, or more, for freedom.

6. Make no mistake about it, it would be better to die in an all out atomic war than to live the way the Russians do, in a police state ruled by men instead of laws. Patrick Henry was right when he said: "Give me liberty or give me death."

Morgin Is Narrowing

I know this sounds grim and gloomy, but the time has come to face the hard facts. The margin of superiority we have over the Russians is narrowing so fast we can't afford to scoff at them any longer. They are on our heels and closing fast.

The reason I feel compelled to say these disagreeable things is this: I have already seen false pride and underestimation of Communists kill American boys. I was in Korea the first day American troops went into action.

We underestimated the enemy then. I don't want the same thing to happen with Russia.

Idlewild Arrival

When we arrived at Idlewild Airport the night of July 22 to board our Boeing 707 jet plane the big graceful swept-wing craft looked like the eighth wonder of the world. But 10 days later, when I flew back into Moscow in a Soviet Tu-104 jet, the American plane was just another jet on the runway. The Tu-104 carries 100 passengers in comfort at 500 miles an hour. We flew them from Moscow through Siberia and back. They land and take off on schedule. Four pretty hostesses served delicious food, fruit and vodka.

American airmen complain that the Tu-104 eats too much fuel, can't operate economically, and has to "hug the ground." I'm sure that's all true. But people who can build as good a plane as the Tu-104 are not going to stop there.

WHO'S WHERE

In the Front Office

Dr. James R. Killian, Jr., a director Gen eral Motors Corp. Dr. Killian chairman of the corporation of Massachusetts Institute of Technology, recently resigned as Presi dent Eisenhower's special assistant for sci ence and technology.

Charles L. Davis and **Clyde A. Parton**, divisional vice presidents, Military Prod ucts Group, Minneapolis-Honeywell Regu lator Co., Minneapolis, Minn. Mr. Davis continues as general manager of the Aero nautical Division, and Mr. Partoo as gen eral manager, Ordnance Division.

Frederick A. Fielden, vice president and general manager, Loewy Hydropress Divi sion, Baldwin-Lima-Hamilton Corp., New York, N. Y.

Rahland C. Zinn, vice president, Lock heed Aircraft Service, Inc., New York, N. Y.

Ted R. Thoren, vice president-engineer ing, Fesco Products Division, Borg Warner Corp., Bedford, Ohio.

George C. Daniels, vice president engi neering, Dynationics, Inc., Orlando, Fla.

Gerald J. Lynch, a vice president, Ford Motor Co. Mr. Lynch continues as general manager of the company's Aeronutronic Division, Los Angeles, Calif.

William W. Wood, Jr., manager of Simulation Engineering, Link Aviation, Inc., Binghamton, N. Y., a subsidiary of General Precision Equipment Corp. Mr. Wood continues as vice president of manufactur ing. Also, **H. G. LeClere**, manager of manufacturing.

Nathaniel H. Goodrich, deputy general counsel, Federal Aviation Agency, Wash ington, D. C. The FAA also announced the following appointments in the Office of International Coordination: **Raymond B. Malov**, chief; **Capt. Donald E. MacIntosh** (USN), deputy chief; **Alfred Hand**, assist ant to the chief; **Carroll D. Heath**, execu tive assistant; **Evan J. Lewis**, chief, Tech nical Assistance Division; **Claude H. Smith**, (acting) chief, International Organizations Division.

William B. Becker, director of opera tions and engineering, Air Transport Assn., Washington, D. C.

David J. Green, vice president-advanced systems development, Tasker Instruments Corp., Hollywood, Calif.

James Fonero, vice president governmen tal relations, TelAutograph Corp., Los An geles, Calif.

James M. Dill, vice president and general manager, Ratigan Electronics, Inc., Glen dale, Calif.

Lowell R. Dailey, deputy assistant di rector, Research Engineering, Department of Defense, Washington, D. C.

Changes

Thomas F. Huntington, executive assist ant to the president, Trans World Airlines, Inc.

Roy Coats, administrative assistant to the president, The Kaynar Mfg. Co., Pico Ri vera, Calif.

Dr. Paul A. Libby, assistant director of the Aerodynamics Laboratory, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

INDUSTRY OBSERVER

► Bidders briefing session for Air Force's new airborne long range inter ceptor (ALRI) program to convert RC-121D aircraft so that it's new AN/APS-95 radar can directly feed Lockheed target information into SAGE air defense system for guidance of long range interceptors and Bomarc mis siles will be held in Dayton on Aug. 13-14. Industry bids are due Sept. 14. Approximately eight to 12 aircraft and avionics companies are expected to bid for prime, including Lockheed, Litton Industries and General Electric. Work involves development of automatic data processing and communica tions equipment plus modification of RC-121D aircraft to accommodate new mission.

► **Plan to establish a single military long-haul communications network through integration and expansion of separate service facilities has been approved by Secretary of Defense Neil McElroy. New Joint Communica tions Network will not include specialized communications such as Strategic Air Command and Air Defense Command control systems or those which form integral part of a weapon system. Joint Chiefs of Staff will be responsible for coordination and control of integrated system which will be developed on evolutionary basis during next 10 years. Operation of system will be paceled out to individual services following a study.**

► National Aeronautics and Space Administration has begun development of a geodetic satellite with the award of a preliminary design contract for the high intensity flashing light system to Edgerton, Germeshausen and Grier, Inc., of Boston.

► **Acquisition and tracking station for Advanced Research Projects Agency's WS-117L Polar-orbit reconnaissance satellite is scheduled to be located in Iowa, supplementing facilities at Vandenberg AFB, Calif., and the Pacific Missile Range.**

► Basic requirements for location of operational sites for USAF's Minute man solid-propellant intercontinental ballistic missile are being studied in relation to a wide variety of terrain characteristics. Parallel contracts have been awarded to ensure adequate analysis of launch area characteristics.

► **Installation of radar and communications equipment at Ballistic Missile Early Warning System (BMEWS) site in Greenland is scheduled to begin within the next several months.**

► Four helicopter manufacturers are in the running for a West German order for a flying crane. Only one is U.S.—Sikorsky Aircraft Division with its S-60. Other competitors are Westland Aircraft, Ltd. with the twin tur bine Westminster; Sud Aviation with its triple turbine helicopter and Italy's Agusta with a triple turbine design using the General Electric T58 engine.

► **National Research Corp. is studying methods of adapting tantalum and tantalum-tungsten alloys for use in nozzles and other hot parts of solid propellant rocket engines under a Navy Bureau of Ordnance contract. Company already has tested one tantalum-tungsten alloy that reportedly has three times the tensile strength of straight tantalum at 4,000F and can be easily fabricated.**

► Ryan Aeronautical Co.'s XQ-2C version of the Firebee target drone has reached an altitude of 59,800 ft. in flight trials. During the trials, the drone demonstrated a speed capability of 560 kt. and the ability to fly at alti tudes of above 50,000 ft. for approximately 77 min. Powerplant is the Continental J69-T-29. Drone is scheduled for delivery to the Air Force in January.

► Kaman Aircraft Corp. reduces chances of fatigue and cuts weight about 5% on its HU2K rotor blade by using a new technique for broaching the aluminum spar leading edge of the 22 ft. blade. Leading edge is an extruded aluminum section extending across a third of the 20 in. blade chord, and the trailing edge is glass fiber honeycomb material. Broaching technique gives the aluminum a smooth interior as well as exterior finish, thus com batting fatigue, and provides uniform blade thickness. Total blade and fitting weight is 168 lb.

Washington Roundup

Hebert Sequel

House Armed Services Investigating Subcommittee headed by Rep. Edward Hebert (D-La.) can be counted on to take steps to discourage financial support by defense contractors of some industry and service organizations engaged in public and congressional lobbying activities.

There will be strong pressure on the military services to disallow support—such as membership dues and assessments—to these organizations as costs on government contracts. The subcommittee also probably will urge the Ways and Means Committee to consider removal of their tax exempt status as non-profit organizations.

Hearings will continue until the adjournment of Congress, probably in a month. A report with recommendations for action will then be issued.

Line of Succession

Department of Defense has defined the line of succession in case of the death, disability or absence of the Secretary of Defense in a new directive. Deputy Secretary Thomas S. Gates is next in line behind Defense Secretary Neil McElroy, and Gates is followed by Army Secretary Wilber M. Brucker, Navy Secretary William B. Franke, Air Force Secretary James H. Douglas and Dr. Herbert F. York, director of defense research and engineering.

These top defense officials are followed in succession by the assistant defense secretaries and the general counsel in order of seniority, the under secretaries of the Army, Navy and Air Force, then the assistant service secretaries, all ranked by seniority.

Space Cadet Corps

Latest twist in the drive to meet the challenge of the space age is a Space Cadet Corps proposed by Rep. Victor L. Anfuso (D-N.Y.). Rep. Anfuso is promoting a bill that would create a corps of space cadets to "encourage and help the young people of the country to take an active part now and eventually to find careers in the space sciences and practical astronautics." Space Cadet Corps would be run from Washington by a corporation backed by representatives of education, aviation, astronautics and related fields. Rep. Anfuso thinks the nation's youth should be marshalled into the corps to encourage development of rocketry, provide education and practical experience in fields allied to the space effort, obtain scholarships and provide personnel for satellite and star watching.

Debate on Fore Debote

Civil Aeronautics Board decision to investigate the $45 economy fares offered by National, Northeast and Eastern airlines between New York and Miami has raised the ire of two thrift minded Board members. Vice Chairman Chan Gurney and member G. Joseph Minetti took their colleagues to task last week for answering a National request to suspend its competitors' economy fares by ordering an investigation of the fares charged by all three carriers.

Pointing out that National uses high capacity aircraft on the flight, while its two competitors offer the service with a lower seating capacity, Gurney and Minetti said National had lived up to Board demands for high density aircraft on low-fare service. Failure of the CAB to grant National's request to suspend the competing fares could be viewed as a rejection by CAB of its past views on economy fares and a breaking of faith with the only carrier which unqualifiedly complied with Board desires on low-fare proposals, the dissenting members said.

Renegotiation Baard

A steady and attentive listener at Hebert subcommittee hearings on allegations of contractor influence on military procurement has been Thomas Coggeshall, chairman of the Renegotiation Board, which has the final say on defense profits unless the contractor challenges its determination in court.

Southwestern Service Case

Local air transportation needs of six southwestern states are now under study by the Civil Aeronautics Board. Under the Southwestern Area Local Service Case ordered last week by CAB, both local service and trunkline carrier route authorities along with community needs will be studied in portions of the states of Arkansas, Louisiana, Oklahoma, New Mexico and Colorado and the entire state of Texas. Airlines participating in the case thus far include American, Braniff, Continental, Delta, Eastern, Trans World, Central, Frontier and Trans-Texas. The new case raises the total of local service area cases now before the Board to seven.

Successor to Keirn

Air Force has named Brig. Gen. Irving L. Branch to replace retiring Maj. Gen. Donald Keirn as Assistant Deputy Chief of Staff, Development for Nuclear Systems. Former deputy commander of Air Force Special Weapons Center at Kirtland AFB, Gen. Branch will take over as chief of the USAF nuclear aircraft program this month.

Branch's appointment fills Keirn's USAF job but leaves unfilled his corollary jobs as director of Defense Department and Atomic Energy Commission efforts in the Aircraft Nuclear Propulsion program. Program management has been a disputed issue in recent months, and a number of proposals for new management approaches have been discussed as a means of speeding progress on the ANP program.

Late last week, no decision was apparent as to whether the program will continue to be managed jointly along present lines or whether some new approach will be adopted.

Iberia Bid Blocked

Iberia Airlines of Spain lost its recent bid for a New York-Mexico City route primarily because the carrier wanted to operate a service not covered by the bilateral agreement between Spain and the U. S. The Civil Aeronautics Board rejected the Iberia application since the Spanish carrier wanted to use the New York-Mexico City route as the third leg of a triangular Madrid-New York-Mexico City route, closing the gap between its current Madrid-New York and Madrid-Mexico City routes. CAB said such a triangular route operation with aircraft operating continuous flights around all three legs, was not contemplated in the Spanish bilateral.

—Washington staff

Defense Budget Cut Below 1959 Level

Congress puts Fiscal 1960 budget at $39 billion; total is $19 million under President's request.

By Katherine Johnsen

Washington—Congress completed action last week on a $39.2 billion defense budget for Fiscal 1960, a figure $660 million below Fiscal 1959 funds.

The final total is $19 million less than the President requested in January, $380 million more than the House originally voted and $766 million less than the Senate originally voted. In some measure the differences reflect technical and military decisions made during the seven months that the budget has been before Congress, rather than basic policy differences between the House, Senate and Administration. Several Administration requests for key programs were changed during the period.

The service allocations for Fiscal 1960 are: Air Force, $17.5 billion; Navy, $11 billion; Army, $9.4 billion. Procurement allocations include:

- **USAF aircraft and missiles, $6.8 billion.** Of this, $4.3 billion is for aircraft, $2.5 billion for missiles.
- **Navy aircraft and related procurement, $2 billion.**
- **Army missiles and equipment, $1.4 billion.**

Allocations for research, development, test and evaluation include:

- **USAF, $1.2 billion.**
- **Navy, $1 billion.**
- **Army, $1 billion.**
- **Advanced Research Projects Agency, $455 million.**

For the first time this year, test and evaluation funds were included in the research and development budgets, rather than in the procurement budgets. About $2 billion for development, test and evaluation in the Fiscal 1960 budget is included in procurement allocations (AW June 1, p. 31).

Air Force's total Fiscal 1960 budget for research, development, test, evaluation and procurement of $8 billion is approximately $600 million above the Fiscal 1959 budget for those categories.

Final budget also gives Defense Secretary Neil McElroy extensive flexibility in the use of missile funds. He is authorized to transfer funds from one missile project to another and has authority to transfer up to $130 million from other defense categories to missiles. In addition, McElroy has a $150 million contingency fund intended primarily for acceleration of missile programs when warranted.

These are the fund details:

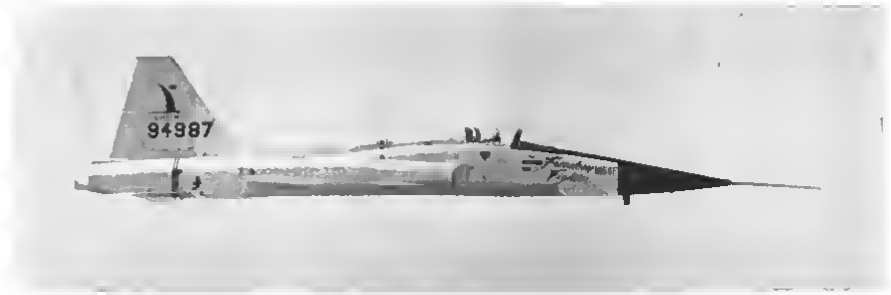
- **Army Nike Zeus** missile defense system. Army has voted $137 million to begin production of the anti-missile missile. Early in the year, Defense Secretary Neil McElroy repeatedly told congressional committees he did not want funds in Fiscal 1960 to begin Nike Zeus production. Nevertheless, the House voted $200 million for Zeus production and other Army modernization programs. During subsequent Senate testimony, however, McElroy supported $137 million for Zeus. In addition, the final budget contains about $300 million for Nike Zeus research and development.
- **Convair Atlas** intercontinental ballistic missile. Funds were provided to finance 17 squadrons. Originally, the Administration had asked for only nine. After the House voted an additional $85 million as a down payment on eight additional squadrons, Secretary McElroy supported the increase.
- **USAF Minuteman.** Solid propellant intercontinental ballistic missile. Congress added $77 million more than the Administration had requested in the budget in order to accelerate development of the USAF solid fuel ballistic missile system. After the House voted the additional amount, McElroy did not oppose it. He also pointed out to the Senate that this would make it possible to phase operational missiles into the inventory six to 12 months earlier than planned.
- **Air defense missiles.** Congress cut funds sought by the Administration proposals for both the USAF Boeing Bomarc area defense missile and the Army Douglas Nike Hercules point defense system. Defense Department's "master plan" for air defense submitted by Secretary McElroy after much congressional prodding (AW Mar. 11, p. 26) called for a reduction of $33 million in the original Fiscal 1960 Bomarc program and $77 million in the Nike Hercules program. Congress went further and made a total cut of $83 million in Bomarc and no less than $100 million in Nike. This still left about $361 million earmarked for Bomarc and an undesignated sum still unspent for Nike Hercules.
- **Navy aircraft carrier.** A total of $35 million is provided to start long-lead procurement for a second nuclear-powered vessel. The Administration had proposed $260 million for a conventionally-powered carrier. The House killed this project. The Senate voted $380 million to launch construction of a nuclear ship.
- **Martin Mace** tactical surface-to-surface missile. USAF is authorized to transfer procurement funds from other projects for this missile, provided Defense Secretary McElroy first certifies to the two appropriations committees that this missile is "essential." Purpose of the House had flatly rejected the $127.5 million requested.
- **USAF aircraft.** Request for $53 million for the purchase of 10 engine jets for Military Transport Service was eliminated. The $24 million requested for 15 jet utility trainers and $23 million for jet navigation trainers originally rejected by the House as "administrative types and not essential" was supported in the final action.
- **MATS.** Congress restricted $45 million of MATS Fiscal 1960 funds for procurement of commercial air transportation. The House originally had proposed $80 million for this, the amount set aside in Fiscal 1959. The Senate had proposed $100 million.

Senate Restores NASA Funds

Washington—Senate last week restored a $68.2 million House cut made in National Aeronautics and Space Administration's Fiscal 1960 budget following a strong plea by NASA Administrator Keith Glennan (AW July 20, p. 26). Glennan had told the Senate Appropriations Committee that "to sustain these cuts in to compromise them will hamstring the U. S. space program."

The $462 million budget voted NASA by the House and the $530 million voted by the Senate were placed before a joint House-Senate committee for decision. The House cuts were $3 million for salaries, $35 million for research and development, $30 million for construction and equipment.

"These cuts could well have crippled our nation's space program," Sen. Lyndon Johnson (D.-Tex.), majority leader, told the Senate. "We certainly should not hobble ourselves in the space race at the very time that our vice president must publicly acknowledge that the Soviets are ahead of us in the thrust of their rockets."



Northrop N-156F Fighter Makes First Flight

Northrop N-156F twin-jet fighter makes its first flight over Edwards AFB (AW Aug. 3, p. 34). Norair Division of Northrop Corp. is developing the aircraft under Department of Defense contract for use by NATO nations. Powerplants are General Electric J85-4 prototype engines rated at about 2,500 lb. thrust each. Production J85-5 turbojets are expected to be delivered to Northrop in September.

USAF to Test Mach 3-5 Fuel in F-104

By Michael Yaffee

Air Force next month will begin flight evaluation of one, and possibly two, new hydrocarbon fuels in a Lockheed F-104 jet fighter at Edwards AFB, Calif., as the next step in its search for high temperature, high performance fuels for future air-breathing aircraft engines that will fly at Mach 3-5 speeds.

In these tests Air Force researchers will be searching primarily for high thermal stability. Future fuels will have to operate at 600-800F without forming filter-clogging sludges. And, for the first time, the researchers will be watching Btu/gal. more closely than Btu/lb., with volume rapidly becoming a more critical factor than weight in advanced aircraft design. (The space-limited F-104, for example, has no room for fuel tanks in its ultra-thin wings.)

Fuel Contracts

Air Materiel Command has already contracted to purchase 100,000 gal. evaluation quantities of the fuel from Esso Standard Oil Co. and Ashland Oil & Refining Co. Scheduled for September delivery, the two fuels now are being prepared to specifications set forth by the Fuel and Oil Branch of Wright Air Development Center's Propulsion Laboratory. Evaluation of the fuels will be carried out by WADC with the assistance of General Electric and Monsanto Chemical Co.

At present, the Ashland fuel comes closer to meeting the Air Force requirement in regard to the desired chemical and physical characteristics and is the favored fuel. It is the one slated to undergo the F-104 flight evaluation at Edwards AFB and possibly a Northrop Snark missile flight test at the Atlantic Missile Test Range. It is a blend of two pure chemical compounds, a monocyclic aromatic (possibly benzene) and a polycyclic aromatic (believed to be naphthalene) which, in this case, is being obtained from coal tar. If the fuel ever reaches full scale production, Ashland plans to use a petroleum starting material in place of the coal tar.

The two aromatics are hydrogenated to form saturated cyclic compounds. Once the two aromatics are obtained, all processing is carried out on standard refinery equipment. Unlike processed petroleum fractions, which usually consist of a number of different compounds, the end product here is relatively pure, consisting of only the saturated versions of the two starting materials with well defined characteristics. Cost of the final fuel is $225,000 for the first 100,000 gal. with Ashland offering AMC a second increment at a somewhat lower price.

The Esso fuel will be evaluated by WADC and results of these tests will determine whether or not it merits actual flight testing. The fuel itself is similar to Esso's Stock G, a relatively high boiling virgin distillate which is extensively treated by means other than hydrogenation to concentrate the naphthenes and remove the unsaturated (aromatic) compounds. Because it is made by processing a crude petroleum fraction rather than coal tar and because the methods of treatment used are less costly than hydrogenation, the Esso fuel is less expensive and will cost AMC only $100,000 for the 100,000 gal. quantity.

On the other hand, the Esso fuel is relatively viscous at low temperatures (144 centistokes at −40F against 12 centistokes for the Ashland fuel), but Esso believes this can be improved by distillation or other processing. Its chemical and physical characteristics are generally less well defined and it is believed to have a somewhat lower heating value.

Primarily, WADC researchers are looking for high thermal stability. To whatever extent possible, aircraft fuels must serve as heat sinks, taking as much heat as possible from the airframe, engine components, and lubricating oil. The fuel should not coke or form sludges that will clog filters and fuel lines at high temperatures.

Fuel Stability

Current JP fuels, mixtures of chain and cyclic hydrocarbons, are thermally stable up to approximately Mach 2 when operating temperatures start running as high as 300-400F. The Air Force, thinking in terms of Mach 3-5 turbojet and ramjet powered aircraft, wants fuels that will be thermally stable at 600-800F. It is now generally be-

Tu-104B Record Claimed

Moscow—Soviets have claimed that the Tu-104B jet transport established five world records Aug. 1 when an aircraft carrying a 15-ton load flew 1,000 km. (621.4 mi.) at a mean speed of 1015.8 km. (631 mph.).

The speed set records for planes with five and 10 ton payloads according to the Russians. Jet transport flew the Moscow-Orsha-Moscow route in 59 min. On the same day, Lt. Col. V. F. Smirnov reportedly set another altitude record in twin jet RV aircraft which attained a height of 20,000 km. (66,256 ft.) with payload of two tons. The same pilot and same plane on July 13th climbed to an 20,300 km. (66,584 ft.) with a one-ton load to claim another record (AW Aug. 3, p. 32).

French Missile Combine

Paris—U S aircraft industry is expected to participate in the capitalization and work of the new French agency for development of long range ballistic missiles. The new combine, called Societe pour les Etudes et Realisation des Engins Ballistiques (AW April 7, 1958, p 62) has headquarters at Courbevoie near Paris in a building given by Sud Aviation, one of the member firms.

The other member French aircraft or engine firms include Nord Aviation, Generale Aeronautique Marcel Dassault, Societe Matra, Sneema and SEPR. Government agencies include ONERA, French equivalent of the U S National Aeronautics and Space Administration and French Defense Department's Service des Poudres responsible under French law for all solid propellant development work.

Technical director of SEREB (initials used to designate the group) is Fernand Vinsonneau, former technical director for Sud's Military Division and before that for Ouest Aviation, one of Sud's predecessor companies.

American observers have been impressed with the speed and direction of the French effort and regard it as one of the most promising technical developments to take place in Europe since World War II.

Some French sources quoted by Aviation Week express skepticism about the organization and believe that, like many of France's postwar projects, this one also will eventually run out of money and therefore out of projects.

A way has been opened for American participation in the French project under a scheme similar to that by which Pratt & Whitney Aircraft acquired an interest in Sneema, the French nationalized aircraft factory (AW Mar 4, p 30). Currently discussions are taking place at high technical levels between American firms interested in solid propellant missile work and the French combine. Governments must approve such agreements.

hoved that saturated cyclic hydrocarbons are more thermally stable than chain hydrocarbons and this is the reason for the Air Force's evaluation of the naphthenic fuels being prepared by Ashland and Esso. Also this type of fuel currently appears to offer the best currently attainable compromise of thermal stability, good low temperature properties, low vapor pressure, high hydrogen percentage, and high density.

In laboratory tests to date both the Esso and Ashland fuels have shown good thermal stability characteristics at the upper temperature limit (450-500F) of the present Fuel Coker Test, forming insignificant amounts of coke or varnish and generally meeting target stability values of preheater elements (maximum of 3) and filter pressure drop (maximum of 1) tentatively set by WADC for its fuel of the future.

As in current fuels, heating values or energy content is an important consideration. But this time, the Air Force will be looking more closely at volume energy values than at weight energy values owing to the increasing importance of the former in present and future space-limited aircraft. Through experience the Air Force also has learned that the relationship of range to Btu/lb is directly proportional. Now they want to establish the relationship of range to Btu/gal, i.e., how much farther will an aircraft be able to go for a given increase in Btu/gal.

For these reasons, along with other objectives that can't be pinpointed in laboratory tests, the Air Force plans to evaluate the fuel in actual flights of an F-104. It would, of course, simplify logistic problems if our fuel could be used in both aircraft and missile weapon systems. Where the fuel of the future is used, it is intended to serve as a total fuel that is it will be used in the turbojet and ramjet afterburner of an engine. General Electric's J93 engine for the North American B-70 and F-108 Mach 3 aircraft is slated to use a hydrocarbon fuel in the turbojet portion and a special chemical (borane) fuel in the afterburner.

On a weight basis the energy content of the new naphthenic fuels compares closely to present JP fuels at approximately 18,500 Btu/lb. On a volume basis, however, the new fuels register roughly 135,000 Btu/gal, compared with 119,885 Btu/gal for JP-4 and 125,300 Btu/gal for JP-6. While the Air Force is placing increased emphasis on the Btu/gal value it would still like to reach a Btu/lb value of 19,000. Another object of the upcoming flight tests will be to help WADC researchers decide if they should compromise Btu/lb or Btu/gal and how far this should go.

The fuels from Ashland and Esso are not the only ones undergoing or scheduled for evaluation by WADC. Almost all major petroleum companies and many chemical firms have submitted samples—some on request from WADC—ranging from gallon to drum quantities. The market potential for this new fuel is an enticing one. According to an Air Force estimate, the demand for an advanced fuel for supersonic engines could reach 100 million gal/year in five to 10 years. Commercial transports, provided that they go supersonic, probably would take 150 million gal./year. Air Force apparently is willing to pay more than the current jet fuel price, roughly 13 cents/gal, to get the performance it wants.

Officially, the present WADC fuel program began two years ago. It got going in earnest a little over a year ago. At this time, WADC contracted with Monsanto Chemical to survey the literature on pure chemical fuels (as opposed to those derived from petroleum cuts), recommend the 50 best chemical fuels and to evaluate these fuels in regard to thermal stability, energy value, etc.

Monsanto now has completed its survey and recommendations and is starting on the evaluation, in which it also will compare chemical candidates with the more promising petroleum fuels. General Electric has tentatively agreed to act as an adjunct to WADC in running ground engine tests that the Air Force requires before a new fuel can be used in an actual flight test. Company will check out the Ashland fuel on a General Electric J79 engine similar to the one used in the F-104.

One-half of the Department of Defense effort to obtain better aircraft and missile fuels, the present WADC program is devoted to improving available hydrocarbon fuels rather than to developing new high energy chemical compounds. Originally, it was felt that these improved hydrocarbons would prove capable of meeting the performance requirements of rockets as well as of air-breathing aircraft engines (AW Mar 23, p 30). Now, however, some Air Force researchers are convinced that liquid fueled rockets with the possible exception of such elements as large recoverable boosters, are headed toward non-hydrocarbon systems.

Avco Is Developing New Titan Nose Cone

Washington—Avco Corp.'s Research and Development Division is designing an advanced reentry nose cone for the Martin Titan intercontinental ballistic missile under a $73,360,000 Air Force contract announced last week.

Object of the contract is to obtain an ablating nose cone with a slender shape that will be capable of maintaining faster speed during re-entry into the atmosphere than that possible with the present blunt nose cones.

The faster re-entry will increase the accuracy of the Titan warhead by reducing the dispersion caused by wind and flight forces during a slower re-entry.

Smaller Sandia rockets (right) with an Allegany Ballistic Laboratory Deacon first stage, Grand Central Arrow second stage were used in studies of effects of high-altitude nuclear blasts on radio and radar transmissions. Total of 65 were fired, some fitted with chaff-ejecting heads to measure wind velocity.

Sandia Corp. two-stage research rockets were fired into fireballs of two nuclear explosions during Atomic Energy Commission's Hardtack I operation last summer from Johnston Island. Rockets, two modified Lacrosse engines, measured nuclear radiation, blast, thermal radiation and electromagnetic effects.

Rockets Probe Nuclear Blasts

Sandia chaff rocket (left) gets prelaunch checkout. Data from Hardtack firings determined that ionizing radiation from the nuclear detonations was sufficient to absorb some radio waves and to scatter others.

Perturbation Cycle Ramjet Model Produces Static Thrust in Test

Los Angeles—Perturbation cycle ramjet which produces static thrust currently is operating in scale model size at Marquardt Co., Ros E. Marquardt company president said here last week.

Lack of static thrust has been a major drawback in these powerplants. Company said a perturbation cycle ramjet is a combination ramjet rocket engine in which the rocket engine distributes the incremental cycle of the ramjet.

The engine envisioned, Marquardt said, is capable of producing thrusts "of a magnitude now considered adequate." Being developed under an Air Force contract, the engine could be used in a concept which has ramjet engines as booster powerplants for space vehicles instead of large rocket engine first stages. Marquardt said the company also holds an Air Force contract dealing with use of ramjet boosters for rocket vehicles.

In addition, Marquardt said, the perturbation cycle engine may have applications to Mach 3 transports.

The company currently is developing ramjet power around the new boron based fuels, Marquardt said, adding that hydrogen also has been used as a fuel in tests. He explained that its low density and large volume required for a given total impulse are current problems. Use of boron fuels looks very promising according to Marquardt, since ramjets have no moving parts in the engine proper and would not suffer the coking and other corrosion and contamination problems of turbojets using boron fuels.

Marquardt also said that design improvements to Boeing Bomarc powerplants could upgrade its capabilities to anti-missile missile applications.

Speaking at a San Fernando Valley luncheon honoring the 15th anniversary of his company, Marquardt also announced the company's financial picture for the first 28 weeks of 1959. Sales totaled $34,051,091; earnings after taxes were $860,647 and earnings per share were 65 cents. These were in contrast with sales of $25,321,270, earnings after taxes of $573,135 and earnings per share of 44 cents for last year.

Marquardt also announced the company will form a new Nuclear Systems Division to handle Project Pluto, the nuclear-powered ramjet, and other possible future nuclear systems. Formerly, Pluto work was accomplished in Marquardt's Astro Division. Alan Grubber will head the new division.

Directors also approved plant expansions at Van Nuys and Pomona, where Marquardt acquired Associated Missile Products, former American Machine & Foundry subsidiary which designs and deals in missile ground support systems and equipment. Expansion expenditures are $1.25 million at Van Nuys and $11 million at Pomona.

Marquardt also said the company's new test facility near Saugus, Calif., has been operating at Mach 8 capabilities, and could be expanded to Mach 17. The facility will continue to be used, Marquardt said, as a research facility, when the Ogden, Utah, plant test facilities are used for production testing, and the Van Nuys test facilities are outgrown.

Zeus Test Facilities

Washington—Construction will start within the near future on test facilities on Kwajalein Atoll and Johnston Island for flight testing of the Army Douglas Nike Zeus anti-missile missile system.

Pacific range facilities will permit the Army to fire Nike Zeus test vehicles from Kwajalein to intercept ICBM nose cones launched along the Pacific Missile Range from Vandenberg AFB, Calif., and special targets fired from Johnston Island, which is within IRBM range of Kwajalein.

Army also is planning to extend the White Sands Missile Range beyond its present northern boundary for initial development and test work on the Nike Zeus system. Plans to build test facilities for the Army missile at Atlantic Missile Range have been dropped.

Project Mercury Pressure Suit

Full pressure flight suit, selected by the National Aeronautics and Space Administration for the Project Mercury man-in-space flights, is a modification of the B. F. Goodrich developed Navy Mk. 4 flight suit (AW June 22, p. 31). Mercury suit differs from the Navy's in its silvered coating for heat and radiation protection, its one-piece construction, and its Air Force type ventilated inner garment. Flight suits will be unpressurized during Mercury flights, becoming pressurized only upon failure of capsule pressurization. Goodrich will supply 20 suits under $75,000 contract.

Saturn Booster Recovery System Detailed

Los Angeles—Methods of recovering and re-using Army's 1½ million-lb. thrust Saturn space vehicle boosters, and Saturn-boosted lunar vehicle designs were detailed here by Dr. Wernher von Braun of Army Ballistic Missile Agency before the western regional meeting of the American Astronautical Society.

Recoverable booster of the three-stage, 162-ft.-long Saturn system will be powered by eight Rocketdyne Thor-Jupiter liquid propellant rockets. Inner ring of four thrust chambers would remain fixed. All four thrust chambers in the outer ring would be gimbaled to make possible attitude control. Fuel and liquid oxygen will be stored in a bundle of nine tanks. A large central liquid oxygen tank will be surrounded by a ring of eight smaller fuel and liquid oxygen tanks.

Von Braun said, "As a matter of probability, we cannot really hope to recover the first Saturn booster in a re-usable condition but we would like to get it back for post-flight inspection and to cannibalize it for re-usable parts." Cook Research Institute of Chicago is doing development work on Saturn's recovery gear.

First mission assigned to Saturn is the establishment of the so-called 24-hr. communications satellite at an altitude of 22,500 mi. over a point on the equator. Fifteen degree per hour angular velocity of a satellite at this altitude equals the angular velocity of the earth's rotation, therefore, if the orbit were from west to east the satellite would appear to remain fixed over the same point on the earth.

Kaiser Steel Co. already has begun construction of a Saturn launching structure at Cape Canaveral, Fla., and should finish around January.

First phase of the Saturn booster recovery will use a cluster of parachutes opened at or near booster apogee. Chutes will be small and strong to withstand the heavy air load imposed by high speeds of re-entry. This means that rate of descent will necessarily be too high to permit recovery of the booster intact, unless some additional deceleration is supplied. Eight small retrorockets will supply the necessary reverse thrust when triggered by contact of a dangling probe with the surface of the sea. A retrorocket will be located between each pair of fuel and liquid oxygen tanks in the outer ring on the periphery of the cluster. Probe would fire the retrorockets at a height of 50 to 100 ft.

An unexpected stumbling block is the task of picking up the big booster after it has been returned to the ground intact. The idea receiving most attention is a plan to modify Navy LSTs as pickup ships. Water ballast tanks would be installed in the bow to make it possible to force the bow ramp beneath the surface of the water. The floating booster then would be winched up the shipway, the ramp raised and the ballast pumped overboard.

Von Braun said ABMA has devised a new simple pyrotechnic starting technique for Saturn which is needed to give simultaneous ignition to the clustered chambers. Saturn propulsion system has a growth potential from 1.5 million lb. thrust to 2 million lb. thrust. As part of the idea that a booster should not be a one-shot item, Saturn has been given the reliability features usually associated with multi-engined aircraft. Fuel system includes continuous cross feed between the clustered tanks in both the fuel system and the oxidizer system to ensure that no single stoppage can force a tank to remain unused.

Saturn will be able to carry out its mission even after the complete loss of one engine.

A total Saturn vehicle would consist of the clustered booster, a Martin Titan first stage, in this case used as the second stage of Saturn, with a Convair Centaur as third stage. Von Braun mentioned two versions of Saturn which could be used for manned lunar flights. One version would be a six-stage vehicle standing 438 ft. high on the pad. Stages one and two would have diameters of 460 in., stage three would have a diameter of 360 in., stage four 256 in., and stages five and six 120 in.

Thrust at liftoff would be 12 million lb. First three stages would be used to place top three stages into a lunar orbit. Stage four would provide energy for soft landing, and would serve as the launching structure for the return trip. The final two stages would remain for the return to earth and re-entry.

Von Braun favors another idea which would use a five stage vehicle with a total length of 304 ft. and a maximum diameter of 256 in. Heart of this plan is orbital fueling of the lunar vehicle. The five stage descendant of Saturn would place an unfueled lunar vehicle in an earth orbit. Five Saturn-boosted tankers would then have to rendezvous with the lunar vehicle and fuel it.

Von Braun said he can see no useful purpose for projected space suits except possibly for lunar explorations. He pointed out that in space there is really no need for legs and hands, therefore, there is no need for complicated suits retaining these features. Von Braun supported the idea of a one or two man space bottle with low thrust rocket propulsion and tool-equipped manipulators useful for construction and maintenance in space.

Satellite Weather Radar

Washington — National Aeronautics and Space Administration will request industry proposals this week for light-weight, long-lived weather radar suitable for use in a meteorological satellite. Radar is intended to give meteorologists a three-dimensional picture of precipitation around the globe (AW June 22, p. 144). Approximately 15 companies will be invited to submit proposals for a feasibility study and construction of experimental equipment.

An-10 Military Version

Moscow—Military version of the Antonov An-10 turboprop transport now in passenger service with Aeroflot (AW Aug. 3, p. 40) is being developed for transportation of troops, light artillery and tanks. This was disclosed by Soviet Premier Nikita Khrushchev during an inspection of a TWA Boeing 707-131 and USAF VC-137 jet transport at Vnukovo Airport.

Khrushchev said he had just returned from Kiev where he saw a demonstration of the military version of the An-10.

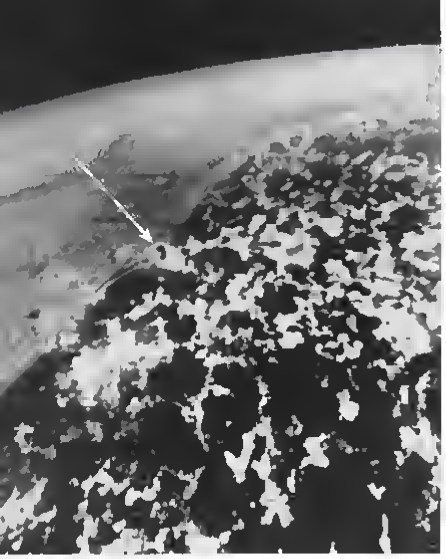
"I will tell you a secret," he said. "That plane can be used for airborne troops. I yesterday saw a self-propelled gun loaded on the plane which landed on a dirt strip and was unloaded very quickly. It can also take a light tank. It is a very good plane."

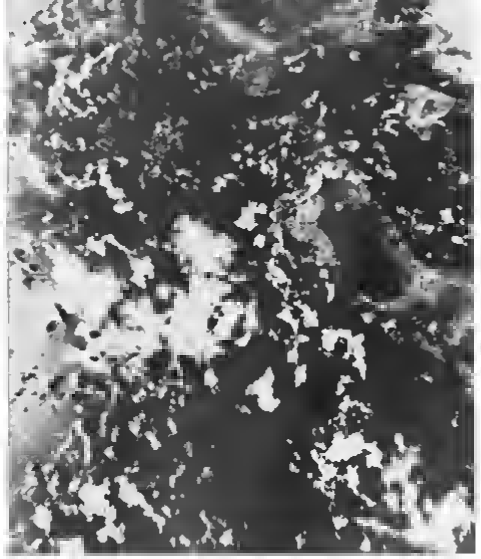
He claimed that the An-10 can fly faster than the Il-18 turboprop transport, but Soviet technical sources do not support this claim listing a 350 mph. cruise for the An-10 as compared with 410 mph. for the Il-18.

Khrushchev visited the Boeing 707 and VC-137 accompanied by Soviet aircraft designer Andrei N. Tupolev and other aviation officials. He jokingly urged Tupolev to "take plenty of pictures" of the interior of the plane.

"Andrie Nikolaivich must try to steal something from you," he said. "All aircraft builders steal from each other. There is nothing unusual about that."

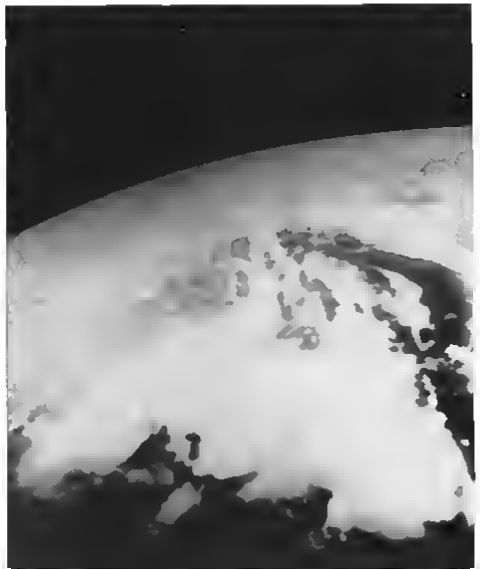
"Some have more opportunity than others," retorted Col. Charles Taylor, USAF escort officer and former an attache in Moscow. Tupolev is credited with copying the Tu-4 Soviet four-engine bomber and the Tu-70 transport from USAF B-29s that landed in the USSR during World War II and were interned.





GE-Thor Nose Cone Photographs Atlantic Missile Range

Cape Canaveral, Fla., is slightly obscured behind main body of an Air Force Douglas Thor intermediate range ballistic missile (arrow, upper left) in a photo made from its General Electric nose cone after separation at a relative speed of about 4 mph. At top right, photo was made of Grand Bahama Island group (upper center) as cone gained altitude. Photos are marked supplement over first nose cone separation film (AW May 25, p. 26). Near apogee (bottom, left) earth curvature is evident and cone is stabilized on all three axes, using sun tracker, infrared sensors and small computer. View is downrange toward British West Indies. Antigua Island is at upper right. In photo at bottom right, cone is over cloud bank that covered about 120,000 sq. mi. of ocean.



Space Technology

GE System Stabilizes Thor Nose Cone

By J. S. Butz, Jr.

Philadelphia—First reorientation of nose cone that began its re-entry backward and the first flight checkout of a three-axis stabilization system suitable for use in an interplanetary vehicle were accomplished during a recent firing of a Douglas Thor intermediate range ballistic missile from the Air Force Missile Test Range, Cape Canaveral, Fla. Nose cone package and instrumentation were provided by the General Electric Missile and Space Vehicle Department here in Philadelphia.

A 16 mm. camera placed in the nose cone to aid in the evaluation of the stabilization system also brought back the most complete U. S. films to date of a ballistic missile flight and the clearest obtained from an altitude of 300 mi. (see pictures).

It has become standard practice over the past year for the Air Force to increase the usefulness of the large ballistic missiles fired in weapon development programs by simultaneously using them to test equipment for space vehicles and to conduct scientific experiments above the atmosphere.

The 1,500-mi. Thor flight on July 24 provided a good example of this "piggy-back" policy combining the testing of tactical weapon systems with basic work needed for the future.

Primary Objective

Primary objective of the July 24 flight was to demonstrate that the attitude control system on a General Electric Mark 2 heat sink type re-entry vehicle could turn it over in case the vehicle made a backward re-entry, so that the heat shield would be facing forward. This vehicle is one of the standard series developed for the Thor and Atlas missiles.

The possibility of a backward re-entry is quite high under normal conditions for heat sink nose cones. Most of them resemble truncated ice cream cones, and this general nose cone shape will fly either forward or backward. They are unstable, however, and wobble, preventing the establishment of stable, laminar flow conditions over the heat shield.

Therefore, these nose cones must have attitude control systems using six gas jets to make certain that the heat shield is facing forward and stabilized to ensure that a successful re-entry can be made. On the July 24 flight, the stabilization system was specifically programmed to initiate a backward re-entry and, once this had been established, the system was released to perform its design function of stabilizing the nose cone in the forward attitude.

The gas jet control system on this flight was of the type specified for a tactical nose cone, but the sensors and computers of the stabilization system were more elaborate and advanced than any needed for an earth-confined ballistic weapon. Two axis stabilization is all that is required for an IRBM or ICBM warhead and this can be accomplished with a number of well proved and reliable devices.

The stabilization system used on this test is advanced enough to be used in the navigation and control of a space vehicle on an interplanetary mission. This nose cone flight was the first known instance of a vehicle in space being fully stabilized around three axes. This is a prime requisite for interplanetary navigation.

The miniaturized infrared sensors, sun trackers and digital computers which were the heart of this system were produced by GE's Missile and Space Vehicle Department, contractors for the complete re-entry vehicle, after a development program which depended upon design data obtained from previous "piggy-back" flights, used to make scientific measurements above the atmosphere.

The three-axis stabilization system that flew in the Thor consisted of two infrared sensors to lock onto the horizon and provide references in the pitch and yaw planes. After these sensors were actuated and the nose cone fixed around local vertical, a sun tracker was used to stabilize in the roll plane and prevent the vehicle from spinning.

The value of this type of system for use in interplanetary travel is that it can operate in a celestial as well as an earth or planetary coordinate system and can transfer between the two as required, depending upon the nearness of a planet.

The complete system includes a digital computer between the sensors and the gas jet control units to convert the observations of the reference planes into command for the controls. A 2.5 lb. computer performed this function on the Thor flight. The infrared sensors weighed about 2 lb. and the sun tracker approximately 6 lb.

Other more advanced units developed in this GE program include an infrared sensor digital computer package which gives commands directly to the control system, that weighs less than 2 lb. Similar packages exist or are in development for very small sun tracker and star tracker units. Depending upon the mission, these three types of sensor-computers may be combined to provide stabilization and control about three axes to less than 2 deg.

The design of the infrared sensors was based upon infrared measurements made above the atmosphere during two ballistic missile flights almost a year ago, one during the day and one at night. These measurements showed exactly the difference in infrared radiation of the earth and its atmosphere and the quality of the interface between the two. Two types of infrared horizon sensors were designed as a result of this work, one which looks at 90 deg. of the horizon and one that looks at all 360 deg. Each of them is able to locate and stay locked on the interface between the earth and the atmosphere to an accuracy of .1 to .2 deg. The device with the larger scanning field is useful at great distances from the earth.

Sun Tracker Design

The sun tracker is basically a simple instrument. It consists of a box with a slit in it and a long strip of sensitized material an inch or so behind the slit and perpendicular to it. There is a break in the sensitized strip so that if the slit is facing the sun directly, none of the light falls on the strip. If the tracker is not aimed directly at the sun, the light shines in the slit at an angle and causes a current to flow through the sensitized strip. This signal is sent to a computer which actuates the vehicle control system so that the tracker is again orientated directly at the sun and the light falls on the null point on the sensitized strip. The difficult part of the design of such an instrument is to get the exact geometry of the slit, the sensitized strip, the orientation of the device, etc., for a given mission.

In-flight monitoring of the stabilization and control systems in the Mark 2 and other types of heat sink nose cones has been highly successful using telemetry. A back-up data recovery system was designed originally into these re-entry vehicles in the event telemetry did not prove completely satisfactory.

This system recorded all pertinent performance data on tape inside a small capsule which was ejected from the nose cone after re-entry had been completed. This capsule has a flotation system and several devices to aid in its location and recovery on the earth's surface.

It was never intended to recover the complete heat sink nose cone because a detailed inspection of its surface is not necessary as in the case of ablation type nose cones. The successful recovery of several of the data capsules ejected after re-entry by the heat sink vehicles has contributed to growing knowledge of re-entry and recovery techniques.

Defense System Coordinates Nike, Hawk

Washington—Mobile air defense system designed to coordinate the efforts of up to eight anti-aircraft missile batteries and developed by Hughes Aircraft Co. for Army use was demonstrated here last week during the annual meeting of the Assn. of the U. S. Army. System can handle either Nike or Hawk batteries or an integrated mix of the two missiles.

The new "vest pocket" air defense system, known as the AN/MSQ-18, is now in limited use with Army units in Europe. A number of MSQ-18s, suitably interconnected to integrate the control of a larger number of Nike and Hawk batteries over a widely dispersed area and designated Missile Monitor, is undergoing evaluation by the Army Air Defense Board at Ft. Bliss, Tex.

The MSQ-18 provides a central point for displaying all aerial targets in a local area together with push button controls which enable an Army commander to instantly assign targets to each of several Nike/Hawk batteries as well as to monitor their progress in tracking and shooting down the targets. The system greatly accelerates the assignment of targets and improves battery integration over the manual-voice communication techniques formerly used.

The "operations central" mounted in a two and one-half ton Army truck, serves as the nerve center for the system. The operations central also can be installed in a small hut that can be transported by helicopter. Inside the operations central are two radar consoles which display aerial targets detected by a central surveillance radar or by other remote air defense radars.

To assign an target, or group of targets, to a specific Nike/Hawk battery, the battalion commander moves a ball-shaped control to position a small cursor around the target blip on the radar scope, pushes a button to indicate the type of weapon warhead to be used, then pushes another button corresponding to the battery being assigned the target.

This instantly transmits a message to the desired battery, causing a similar cursor to appear on its tracking radar scope to show the target or targets assigned for its action. When the battery radar begins to track the assigned target, its aiming point is automatically transmitted back to operations central and displayed on the master radar console. This enables the commander to determine whether the battery is tracking the correct target. Battery operator also reports back when his radar is on target and when the target is within range of the missile and on the effectiveness of engagement using push buttons. All such information is displayed for the battalion commander.

In addition to the mobile operations central, MSQ-18 consists of a truck-mounted coder-decoder unit located at each battery site which converts messages from operations central into appropriate displays and converts battery operator inputs into suitable messages for transmission back to operations central. The messages which are handled in digital form can be transmitted by radio or land lines. When used with Missile Monitor, where individual missile batteries are widely dispersed, the coder-decoder equipment also corrects data on target location for difference in location between central air defense radar and the particular missile battery.

The MSQ-18 is being produced by Hughes Aircraft's Ground Systems Group, Fullerton, Calif., under a $30 million contract awarded in 1958.

First system was delivered to the Army late in 1957 for evaluation at Ft. Bliss and was officially accepted in March 1958.

Lt. Gen. Arthur G. Trudeau, Army chief of research and development, told the AUSA meeting that communications and electronics have enabled the Army to make necessary increases in its command and control capabilities, but he warned industry of a need for more standardization. Trudeau noted that contractors are tending to build up their own electronics capability, and that this trend is resulting in a fractionalization of industry. One result, he said, is the appearance of similar but non-standard items in various missile systems, complicating maintenance and logistics problems.

Along with an urgent need for standardization, Trudeau stressed a requirement for development of more efficient machine tools. He said the need for advanced machine tools to make the production process more efficient is a major challenge to industry.

Trudeau has ordered preparation of a classified brochure aimed at giving industry a complete briefing on the current status of the Army research and development program and on its long-range plans. Purpose is to give qualified contractors ideas and goals they can use to help the Army advance its research programs. The Army chief of ordnance already has a similar document defining its qualitative development requirements for industry.

AIR BATTLES can be monitored and targets assigned to missile batteries from controls at tactical display screen of Hughes Aircraft Co.'s air defense system's command center. System is being produced under a $30 million Army contract.

GE Will Develop Army Turbine VTOL System

Washington — A turbine-powered ducted fan propulsion system for VTOL aircraft will be developed for the Army by the General Electric Flight Propulsion Division.

GE will develop a propulsion system which uses bypassed turbine engine air to drive a turbine wheel attached to the rim of a ducted fan for lifting a VTOL vehicle, then uses conventional turbine thrust for forward flight.

Army contract calls for fabrication, test and analysis of a prototype system.

GE system will use a valve to divert the airstream from a turbine engine into an annular duct around the lift fan. Lift fan will have turbine buckets attached outside its rim, and the airstream will be turned downward through this tip turbine, during the lift fan and providing a certain amount of direct thrust.

Powerplant will be one of the group developed at the GE Small Aircraft Engine Department which includes the 164, T58 and J85.

In VTOL operation, the lift fan would be used for vertical lift, with the thrust vector controlled by exit vanes. As the VTOL aircraft moved into forward flight, the diverter valve would be closed, shutting down the fan and converting the turbine engine to use for forward thrust.

GE says the system is designed to obtain good operating efficiency from the turbine engine in cruising flight and to use the lift fan to augment turbine power in vertical takeoff and landing procedures.

System can use either one or two engines. Fan could be fitted in the fuselage between two powerplants or dual fans could be used on the wing on either side of a powerplant installation. GE said a VTOL transport powered with four of these units could carry a 4,000 lb. payload 600 naut. mi. at speeds ranging up to 320 kt.

Lacrosse Fired in Army Exercise

Army Martin Lacrosse surface-to-surface guided missile is about to be fired (above) during Army exercise. Below, an angulin tracker (foreground) is adjusted to pick up signals from Lacrosse as it is propelled toward a target. Power supply unit is at right, below, and a computer and a range and direction finder are at left, below. The Lacrosse weapon system also employs a target ranging set to determine exact range and direction of a target. The operator of the target ranging set lines up his equipment by sighting through a built-in binocular system. Lacrosse, produced by Martin Co. in Orlando, Fla., is capable of delivering a nuclear, shaped-charge, or conventional warhead. System can be airlifted.

Pace Defines Views on Industry Hiring

Washington—Frank Pace, board chairman of General Dynamics Corp., told the House Armed Services Investigating Subcommittee last week that the light of publicity is the surest protection against any attempts by defense contractors to influence the spending of public funds on obsolete or unnecessary weapons for private profit.

In this connection, Pace said the subcommittee's eminent investigation into allegations of a U.S. "munitions lobby" would be of major benefit.

Pace stressed that the possibility of a contractor influencing the use of procurement funds is small but said that opportunities for improprieties do exist and "should not be ignored." He recommended:

- **That no prohibition be placed against** engineers and technical personnel going directly from military service into defense industry employment. Subcommittee members concerned on this.
- **That there be a two-year cooling off** period before officers having "direct contact with industry" who in the service could be employed by defense industries. Pace readily admitted that his inside knowledge of government operations gained during four years' service as director of the Bureau of the Budget and as Secretary of the Army played a role in his employment in 1953 as executive vice president of General Dynamics.
- **That the retirement pay of military** officers should be suspended while they serve in civilian government positions.

Pace added that the worst situation would exist if industry and government were afraid to talk to each other. He said that situations always will arise in military procurement in which "the integrity of men is the determining factor."

Association Testimony

Pace was the leadoff industry witness to appear before the subcommittee last week following two days of hearings into the activities of major service organizations—the Air Force Assn., Assn. of the U.S. Army and the Navy League. Statements on the financial status of the three organizations included:

- **Air Force Assn.'s** total 1958 income was more than $1.2 million. Army Assn.'s was $582,617; the Navy League's $179,247.
- **1958 advertising income** of AFA's magazine, "Air Force and Space Digest" was $526,807. The 1958 advertising income of Army Assn.'s "Army" magazine was $143,402. Navy League's "Navy" stood at $32,000.

Rep. Hebert said that the subcommittee is interested in determining the type and extent of the operations of associations that have axes to grind in influencing public opinion and the Congress. The subcommittee has sent questionnaires to 30 defense organizations, including Aerospace Industries Assn. (AW Aug. 3, p. 31).

AFA President Peter Schenk told the subcommittee that AFA retains its objectivity in evaluating the weapon systems which it promotes and that we are not the civilian arm of the Air Force. "Nor are we the Assn. of the U.S. Air Force."

Both Army Assn. executive vice president, retired Lt. Gen. Walter L. Weible, and Navy League President Frank Gaud Jameson proclaimed their pro-service outlook. Gen. Weible said that "Army" obtains its information from Army public information personnel. Jameson said: "If we are not for the Navy, we have not reason for existing."

Rep. Porter Hardy (D-Va.) disputed AFA's protestations of objectivity by an organization that is so obviously a protagonist. "You protest too loudly."

Schenk cited AFA's advocacy of a single service as an example of its objectivity, since "many in the Air Force did not agree with it." Hardy replied that members of the subcommittee who have handled defense organization since the original unification act over a decade ago are very well aware that the

Canvair Red-Eye Missile

Red-eye surface-to-air guided missile system will be developed by Convair (Pomona) Division of General Dynamics Corp. under $6 million contract awarded by Army Rocket and Guided Missile Agency, Army Ordnance Missile Command. Missile contains propellant, high explosive warhead and electronic guidance system. Weapon will be used by Army and Marine Corps against strafing aircraft. Launcher is 4 ft. long, 3 in. in diameter and weighs 20 lb. When capped at both ends, launcher tube serves as shipping container.

military service in favor of a single service is USAF. Rep. Leon Gavin (R-Pa.) added that AFA wouldn't submit an Army or Navy command for the single service by any stretch of the imagination.

Army Assn. and Navy League declared that they avoid downgrading the weapon systems of other services in "reiterating the public on the importance of the weapons of their own services. We unstintingly and conscientiously avoid adverse criticism of others," Gen. Weible said. In the fight between Army's point defense Nike Hercules system and the USAF-Boeing Bomarc defense system, Weible said: "We never said anything against Bomarc in pointing out the capabilities of Nike."

Schenk maintained that AFA takes sides in such battles. In intermediate range ballistic missiles, he said, AFA argued openly for USAF's Thor and called for elimination of the competing Army Jupiter and, in the Nike Hercules-Bomarc controversy, proposed elimination of Army's Nike.

Hebert proposed that military unification is made difficult by associations "supported by contractors" which turn to mobilize public and defense opinion to line up with one service.

Employment Stand

AFA urged that all bans against employment in defense industries of retired military personnel be removed. Army Assn. and Navy League opposed any further restrictions than the present two-year ban prohibiting retired officers from selling to their former services.

"Waiting periods before a retired military man can do business with the Department of Defense only clouds the issue," Schenk told the subcommittee.

Cooling off periods only decrease a man's knowledge of a given situation; they do not strengthen his integrity.

The competence and integrity in the case of general officers has been certificated by the U.S. Senate. "We can not believe that these military leaders hang up their integrity in the closet along with their uniform." Hebert replied that a military man is still a human being and not an angel.

Under questioning, Schenk said he saw no objection to "the same man changing sides at the negotiation table from one day to the next."

Schenk called for strengthening the partnership that has developed between industry and the Department of Defense. He said that frequently industry's contribution is the key factor in determining military requirements. Indeed, there are highly placed military men who sincerely feel that industry currently is setting the pace in the research and development of new weapon systems," he added.

Details disclosed in the associations' questionnaires included:

- **AFA listed** its 1958 entertainment cost at $2,968 expended in selling advertising for its magazine and industrial exhibit space at its Airpower Panorama staged in connection with AFA's annual convention in Dallas. Army Assn. reported $2,381 for entertainment; Navy League nothing.
- **AFA's 1958 national convention** involved a net loss of over $67,000. Income of $102,000 was more than offset by costs of $169,000.
- **AFA's Airpower Panorama** resulted in a profit of $44,000. Income totaled $108,000; expenses $64,000.
- **Army Assn.** reported a 1958 income of $71,000 from registration functions and exhibits at symposiums and meetings.
- **1958 salary expenses were:** AFA, $295,000; Army Assn., $150,000; Navy League, $43,000.

Crash May Cancel Coleopter Project

Paris—Sneema may drop its Coleopter VTOL project as a result of the aircraft's near total destruction when it crashed and burned during a recent test flight.

Test pilot Auguste Morel escaped with slight injuries following ejection from an altitude of less than 225 ft. The annular-wing aircraft, which first flew April 17, burst into flames when it hit the ground.

Coleopter airframe was built by Nord Aviation for Sneema. Powerplant was a specially rigged Atar turbojet. The fact that only one prototype of the Coleopter exists probably means Sneema will be forced to shelve the project which has been under development for over three years. French government has been reluctant to finance the project all along.

First reports indicated the accident followed initial attempts by Morel to convert from vertical to horizontal flight. Officials at the flight test center at Melun-Villaroche, where the accident happened, denied this was the case. They said Morel lost control of the Coleopter when, having completed several inclination maneuvers, which previously had been successful, he tried to stabilize the aircraft for its vertical descent. Sensing a lack of control, Morel declared an emergency and ejected.

Coleopter was equipped with a low-altitude type ejection seat developed by Sud Aviation. Ejecting at 225 ft., Morel's chute broke open at an altitude of about 12 ft.

Qantas Carries Extra Pad an Baeing 707-420 Jet

Spare Rolls-Royce Conway turbojet engine is hung in an extra pod below the wing of a Qantas Empire Airways Boeing 707-420 Intercontinental jet transport. Called Pod Pak, the unit's fairings are streamlined at both ends, normal pod cowlings enclose the sides. Strut is suspended from the front wing spar by two fittings and to the landing gear support rib by four bolts, no structural changes are involved in the 707-420's wing. Use of the pod eliminates the need for a large stock of engines at any point other than major airports along the airline's route. Pod can be carried during normal operations.

News Digest

James L. Anast's resignation as president and director of Lear, Inc. less than four months after he stepped into the top position was announced last week by the company's board of directors. Anast, who took over the presidency in a top management shakeup (AW April 13, p. 35), will be succeeded by Albert G. Handschumacher. Handschumacher, a vice president of Rheem Manufacturing Co. until his appointment to the Lear presidency, is a former senior vice president of Lear.

Lockheed Aircraft Corp. reported sales increased in the first half to $607,903,000, or 31% above the $465,735,000 recorded in the first half of 1958 but that earnings dropped 9%—from $9,743,000 or $1.65 a share to $8,840,000 or $1.37 a share. Transition from the Constellation to the Electra turboprop transport program was blamed for the drop in net. Backlog as of June 28 was $1,032,281,000, a decline compared with $1,214,972,000 a year ago but an increase over the $956,534,000 reported three months ago. Missiles and Space Division sales reached $230 million; civilian airplane and other sales totaled $123 million.

Radio Corp. of America will develop cable microwave networks to link Minuteman ICBM silos and launch-control centers (AW Aug. 3, p. 93) under a contract awarded by Boeing Airplane Co., Minuteman Assembly and test contractor. Radiation, Inc. has received an additional $1,900,000 contract for the ground portion of Minuteman PCM/FM telemetry equipment from Boeing. Radiation, Inc. recently received a $4 million contract for airborne telemetry equipment for Minuteman (AW July 20, p. 32).

Consolidated Systems Corp. received a $98,600 contract from NASA's Goddard Space Flight Center for development of miniature mass spectrometers to be placed in a 35-in.-diameter satellite to be orbited in 1961 and to measure and analyze elements of the upper most region of the atmosphere, the exosphere.

Republic Aviation Corp. reports sales of $109,812,737 and net income of $1,577,807 for the first half of this year, compared with sales of $86,374,821 and net income of $1,528,967 for the same period last year. Earnings for the six months this year were $1.07 a share, compared with $1.04 a share for the same period last year. Backlog as of June 30 was $532 million.

Ozark Pegs Growth to Federal Subsidy

Midwestern airline, now starting turboprop service, sees basic role as non-competitive with trunklines.

By Glenn Garrison

St. Louis—Ozark Air Lines has keyed its current route expansion and re-equipment programs to the principle that local service carriers must rely on federal subsidy for future growth.

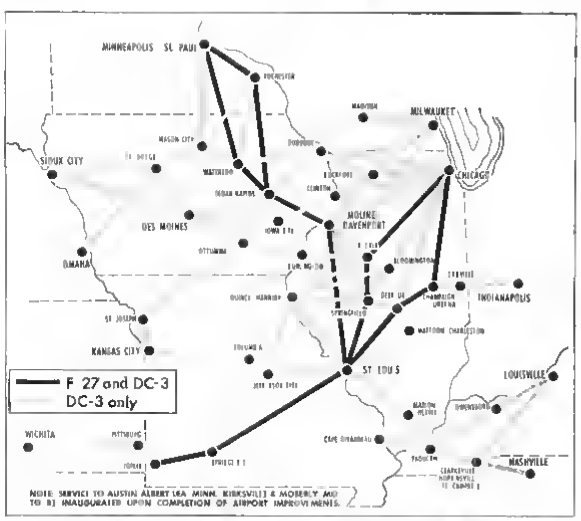
The midwestern airline, which last week received the second of three Fairchild F-27 turboprop transports and has recently seen its route mileage grow 46%, wants to remain a local service carrier. Ozark thus belongs to the school of thought expressed by some financial sources in the controversial local service financing question (AW June 8, p. 37).

Ozark management sees the carrier's basic role in the transportation picture as interdependent and not competitive with the trunk carriers. And because Ozark's part of the job is to serve small and intermediate points where traffic and revenues are relatively light, the airline does not believe it can or necessarily should be self supporting.

Ozark, one of the largest local service airlines, expanded its operations last March from 18,597 to 26,930 scheduled airline miles a day in activating new routes awarded in the Seven States Area Investigation Case of the Civil Aeronautics Board. Its fleet of 20 high performance and four standard Douglas DC-3s now serves 52 cities in 10 midwestern states and traffic runs about 50,000 passengers a month.

The carrier financed its F-27 purchase through the CAB Guaranteed Loan Program, raising $2,118,996 for the aircraft and spares. It also has issued 132,944 additional shares of common stock to broaden its equity base and to provide $551,530 for ground support equipment, development and working capital.

In linking the smaller points with the big cities of the Midwest, Ozark competes with the trunklines at only a few points and 70% of its traffic is connecting.



INTEGRATION of Fairchild F-27 turboprop transports into Ozark Air Lines' route pattern is detailed above. F-27s will serve city pairs that generate 48.8% of its total traffic.

"We're a feederline period," Joseph H. FitzGerald, executive vice president and general manager, told AVIATION WEEK. FitzGerald, formerly director of CAB's Bureau of Air Operations, is heading the airline while President Ladd Hamilton is on leave of absence.

The small and intermediate cities, FitzGerald points out, must be served and among them the middle-sized prosperous cities require a high frequency of flights. Yet there is not sufficient traffic to justify frequent trunkline schedules, and Ozark fills the gap.

"We're not the two-round trips-a-day boys over these routes," FitzGerald said. He foresees some improvement of Ozark's routes as the trunklines get larger, faster airplanes and move out of the medium sized cities, but not enough improvement to alter the basic character of Ozark's system.

This basic character is not self supporting. To be self supporting, Ozark would have to change its pattern of service, get nonstop and long-haul routes in the high density markets. And because the trunklines would not relinquish these markets, Ozark would have to compete with them, and it is not designed to do this.

Local service carriers vary greatly not only in their route patterns but in their "aspirations," in FitzGerald's view. Ozark is perhaps more a feederline than any of the other local service carriers, he said, and it never expects to become a regional carrier.

Regarding a possible commuter type no-reservation service proposed by Allegheny Airline President Leslie O. Barnes (AW April 6, p. 38), FitzGerald believes it is a good approach for Allegheny but not for Ozark. Reason: because Ozark's business is so preponderantly one of connecting with the trunk carriers, reservations are necessary to protect the passengers over-all trip.

A major problem faced by CAB and the feeder industry, in FitzGerald's view, is the expanding need for government support because of the expanding total of points served. While the subsidy need per plane mile has declined because of increased efficiency of operation, the total need nevertheless is greater. The Ozark official believes CAB will devise a new mail rate formula providing the business incentive to keep costs at a minimum and yet to expand service.

In this connection Ozark has effected a reduction in maintenance costs of its DC-3s from over $34 to under $32 per flight hour, including increased wage costs of about $1 per flight hour.

Ozark expects to prove out its initial F-27 program within about a year of start of service, FitzGerald said. Three aircraft were ordered for this first phase as the minimum number practicable. If the program proves successful, five aircraft would be optimum for the present stage of Ozark's development, according to FitzGerald. The turboprop is not considered a replacement for the airline's DC-3s but as part of an integrated fleet.

Added capacity rather than frequency is needed on some segments, while on others there is presently little prospect of filling additional capacity. Ozark's DC-3s have 21- and 27-seat configurations. The F-27s will seat 40 and will require at least eight more passengers per mile than the DC-3s to achieve the same economic results. The F-27s also can compete with trunkline equipment over the few Ozark route segments that are competitive.

The new aircraft is expected to be particularly useful at Chicago where 25% of Ozark's traffic is developed and where frequencies are limited by terminal conditions. Another problem at Chicago with the DC-3s is the bad weather limitations that restrict advance bookings to 21 passengers during the winter. If weather turns out to be suitable, the full 27 seats can be filled. Ozark's July schedules called for 25 weekday departures from this city.

Ozark's turboprops will go in service between city pairs that in 1958 generated 48.8% of the airline's total traffic. Only two cities not in this high density category of Ozark's routes will be served by the F-27.

During the first year of operation, the carrier expects to get a 6 hr. 43 min. average daily utilization from its F-27s compared with 5 hr. 27 min. from its DC-3s in that period.

Financial effect of the new equipment as estimated by Ozark indicates subsidy needs of $4,367,000 for the year ending Aug. 8, 1960 as compared with $2,741,000 for the year ended Feb. 28, 1959, and $2,023,000 for the six months ending Aug. 31, 1959. For the year ending Aug. 31, 1961, subsidy need will be $4,135,000 and for the year ending Aug. 31, 1962, the need will be $3,859,000, in Ozark's estimate.

Ozark selected the F-27 as the aircraft best suited to its particular needs, noting again the variation in needs among the local service carriers with different operational as well as traffic situations. Ozark's own routes lie over a low, flat area and the highest point in its system is 1,300 ft. Its average stage length is about 86 mi. Under the given conditions, Ozark's studies showed that the most efficient piston types had higher seat mile costs than the turboprop in addition to the obsolescence of the piston aircraft.

Considerable shopping around for a loan for its F-27 program was reported by Ozark to CAB in its application for a loan guaranty, as follows:

"Ozark Air Lines has handled its major financing with the Bank of St. Louis since the beginning of its operations, however, in approaching the financial requirements of the F-27 program involving approximately $2½ million it became apparent that it would be impossible to handle the complete financing with the Bank of St. Louis due to its loan limitations of $1 million.

"It appeared Ozark could obtain its necessary financing from either local area or New York banks, provided a government guarantee on the loan could be obtained. Thus, it became a question of determining which would be the better source of capital. The decision was made to handle the financing on a local basis and necessary negotiations were held with the City National Bank and Trust Company and the Mercantile Trust Company. In addition to banks, Ozark explored the possibility of buying two F-27 aircraft from Wohl and Associates, New York City. These negotiations were broken off because of the inability to obtain financing for longer than a five-year period.

"Discussions were also held with Cruttenden, Podesta and Co., an underwriting firm in Chicago, regarding the terms and possibility of issuing debenture bonds coupled with a guaranteed loan in the amount of our financial requirements rather than by handling it through long term bank loans. Because of the uncertainty of the market for such bonds, this idea was discarded.

"In its attempts to secure loans on a non-guaranteed loan basis, Ozark believes that it explored the market thoroughly, both directly and by review of the experience of other local service carriers that have negotiated equipment loans. Except for the five-year proposal made by Wohl and Associates which would have involved the additional costs of a lease-option program, no other non-guaranteed loan was available. Ozark was specifically advised by the banks that they would not consider a loan for as long as a 10-year period without a government guarantee."

France Gains West Coast Stop

Washington—France last week gained access to the U.S. West Coast in a compromise agreement reached at the conclusion of bilateral negotiations in Paris. The agreement marked the end of an impasse that began over one year ago when the French renounced their air transport pact with the U.S. (AW July 28, 1958, p. 30).

The new proposed bilateral, which must still be formally ratified by the two nations does not, however, give France the principal goal it had sought—a New York-West Coast route (AW Nov. 17, p. 38). Here's what it does provide for France:

- Polar route from France to Los Angeles or San Francisco.
- Traffic rights from Paris to Anchorage on a Paris-Tokyo route already in effect.
- Addition of Baltimore to a New York-Washington route.
- Route from New Caledonia or Tahiti to Honolulu and beyond to either Los Angeles or San Francisco.

U.S. carriers in turn were granted the rights to serve both Marseilles and Nice on Far Eastern routes. Under the old pact, U.S. airlines had authority to serve only one of these points. In addition, American carriers received duplicate operating authority over the New Caledonia and Tahiti route granted the French.

State Department officials here say the significance of the agreement lies in the fact that major portions of the bilateral to which France had objected remain in the new agreement.

France denounced the 13-year-old pact last year after failure to convince the U.S. that the French should have 'double truck' rights, or duplication of any routes granted U.S. carriers. Major concern of the French was a desire to cut back on both the number of American carriers serving France and closer control of traffic capacity.

French delegates also pointed out that, while the U.S. has three carriers—Seaboard & Western, Pan American, and Trans World Airlines—serving France, only Air France entered this country. U.S. original stand was that France should not have any more routes than it already had.

In New York, Trans World Airlines said it was "pleased that the French and U.S. governments have reached agreement on the bilateral." Pan American World Airways had no comment.

Basis of France's renunciation of the treaty—which formally expired in June—and its demands for new routes was the fear that the large increase in seating capacity from the introduction of U.S. jet transports would seriously cripple Air France in the New York-Paris market.

Board Registers Objections To Local Airline Rate Proposal

Washington—Local service airlines are restudying a Civil Aeronautics Board proposal for revised class rate formula for subsidy payments following CAB objections that modifications in the plan suggested by the carriers could result in subsidy payments higher than those planned by the Board (AW May 11, p 40)

Changes in the proposal recommended by United Research, Inc., a private research firm employed by the Assn of Local Transport Airlines and the Air Transport Assn., would constitute a significantly new subsidy formula if adopted, according to Board economists

Designed to replace the complex mail rate proceedings now in effect, the Board's original plan calls for monthly subsidy payments based on a per-route mile rate dependent upon frequency of flights and assumed passenger loads and would allow carriers a reasonable profit as part of the subsidy payments

United Research extended the Board's basic plan to include the addition of a station subsidy and an allowance of 10% of operating revenues to be deducted from the combined sums of station and mileage subsidies. United Research also recommended that subsidy payments be applied to 12 daily round trip flights as compared with the six suggested by the CAB plan

Emphasizing the magnitude that the subsidy payments could theoretically reach if the full United plan was adopted, the Board estimated that increases in flight frequencies by the local service carriers to obtain maximum subsidy would cause the annual bill to "leap" to $89.5 million based upon 1958 route structures. The many new routes authorized since then, the Board said, would bring the total to almost $120 million. Subsidy payments under the present formula totaled $36.7 million for the 13 local service airlines in Fiscal 1959.

Calling attention to its limiting of subsidy payments to the first six daily round trips for each route segment, CAB said that this number exceeds the maximum now being operated by most local service carriers.

Commercial revenues, CAB said, should cover an increasing share of the costs of operating a route segment as flight frequencies are increased. It said, for example, that this revenue should cover 46 cents of each dollar's expense on a two round-trip segment, 60 cents a three round-trip segment. For subsidy purposes, the Board added, public service requirements will be adequately served by a maximum of six round trips a day per segment.

Local service concern over the Board's use of Douglas DC-3 operating costs as a base for compiling operational cost for new equipment such as the Convair 340 and Fairchild F-27, also was noted by the Board.

CAB said studies it conducted showed that in spite of the various problems" of integrating and operating new planes, their cost per seat mile during integration did not generally exceed that of the DC-3 and that in the case of the F-27, was substantially the same.

Increased utilization and proved efficiency with the new aircraft in the future should provide the airlines with a "cushion" in the form of reduced unit costs, the Board said. It added that the growth of subsidy payments, now being experienced and attributed to the larger equipment, is more properly a result of the lag of utilization of capacity offered.

CAB also rejected a United recommendation that machinery of the program be reviewed quarterly instead of annually. The Board said it regarded this suggestion as "clearly unworkable" since it would involve such a volume of material that a full-time staff would be needed to recompute all the factors within the formula.

Durfee Favors Routes Based on Traffic Flow

Washington—Civil Aeronautics Board Chairman James R. Durfee believes local service airlines should be granted route awards based upon traffic flow area as a means of attaining greater management independence. Awards are now largely based upon distinct geographical areas served by the airlines.

Speaking at a recent regional meeting of the Air Line Transport Assn., in Fairbanks, Alaska, Durfee also termed CAB's proposed class rate subsidy formula as a "new look" intended to rationalize the distribution of subsidy payments and stabilize the financial health of the carriers. Adoption of the new formula, he said, would eliminate the "second guessing" of airline management by the Board and restore the confidence of the taxpayers in local service operations. Absence of a rational scheme, he added, could result in a loss of this confidence on the part of both taxpayers and Congress so that they "will begin to question as they did this year, the rising subsidy bill."

Terming the Board's present route award procedure as a "cumbersome process" which "causes far too great an amount of delays, complaints and dissatisfaction," Durfee told ALTA members that Board and to local service airline growth may best be accomplished through CAB attention to three general tasks. They are:

- **CAB must lay down boundaries** for local service operations in order to limit duplication that increases costs and wastes subsidy. Durfee said he favors a route standards program by which an area would be permanently marked out for a carrier by traffic flow. The carrier should be given a monopoly "for the time being," Durfee said, with the freedom to provide all needed local service, decide which cities can support this service within the allotted subsidy, determine routings and schedules and other similar management decisions. He added that, while CAB would still have to hold route hearings to adjust boundaries between carriers and redefine the relative tasks of local and trunk airlines, the plan would still offer the best chance for management control and initiative under subsidy regulations.
- **Adoption by the carriers of the** Board's proposed class rate formula for subsidy is the only means by which the local service airlines can accomplish a more independent route program, Durfee said. He emphasized the importance of CAB's duty to get the maximum amount of local service transportation from each subsidy dollar while seeing that it is spent to improve the general air transportation system.
- **Many "hard and fast" rules** imposed on local service carriers should be lifted to provide greater management incentive. Durfee said Board policy in placing special local service restrictions on top of linear route descriptions on the airlines has assured a minimum number of stops for a certificated community but also has "hobbled" management to the extent that the carriers have often been denied the necessary flexibility to provide the kind of service actually needed by the communities.

"I would far prefer to see the Board checking the exercise of a less restricted management discretion than prescribing these hard and fast rules," Durfee said. He added:

"The alternative to this kind of scheme, however, is a continuation of a scheme that has government looking over your shoulder at every move you make, requiring prior approval of every step you take and second guessing you on every decision . . . and doing this with an organization that cannot hope to grow large enough, fast enough to meet the problems you face with it. What we want is to keep management out of the Washington hearing rooms . . . there aren't any passengers to be sold there."

FAA Fines PanAm on Operation of 707

New York—Pan American World Airways has paid a $500 fine to Federal Aviation Agency for an operating violation in connection with the Boeing 707-120 which was involved in an emergency landing at New York International Airport on July 11. The fine, however, relates to a Dec. 24, 1958, operation with the aircraft and not to the flight that turned back to Idlewild after losing two main landing gear wheels on takeoff.

A second violation charge, now being processed by FAA's legal department, covers operation of the plane on July 10 without a snubber assembly. The first charge concerned operation without a snubber and operation without a fusion plug in the wheel. Pan American says the wheel was delivered without the fusion plug. The airline and FAA differ as to the essential nature of the snubber for safe flight. Pan American's manual, however, has recently been changed to require an operative snubber.

The snubber, a landing gear part designed to dampen the oscillation of the gear truck after takeoff, is the subject of one of three minor gear modifications Boeing has decided on after tests following the Idlewild emergency (AW Aug. 3, p. 35). Excessive oscillation of the truck beam, resulting in contact with another part of the landing gear, is believed to have weakened the beam and led to its failure in the July 11 takeoff.

Pan American's position, as expressed at a recent CAB hearing in New York by R. M. Adams, maintenance manager of the airline's Atlantic Division, is that the snubber performed a desirable function but was not considered an essential safety item. On about July 1, Adams testified, this item among others was discussed with FAA and it was decided to change the carrier's maintenance manual to require an operative snubber at all times. But Adams said, there was no indication that this was an emergency item and the revision was not published until July 15. An Airworthiness Directive requiring inspection of truck beams was issued July 24.

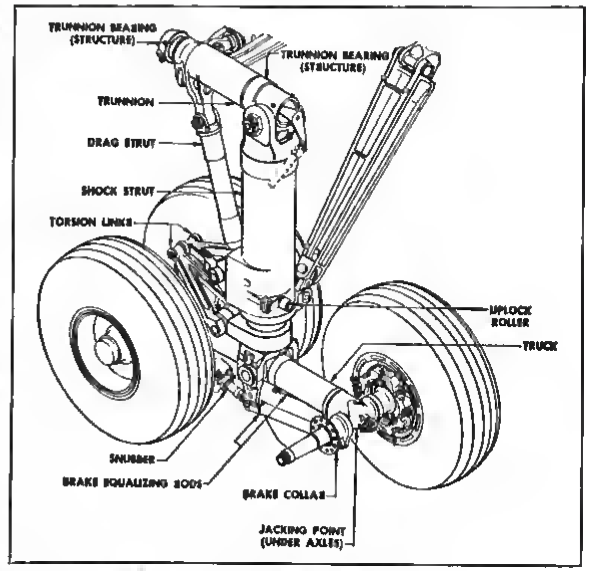
Robert Crothers, FAA maintenance adviser of the International District Office, testified that the item had been discussed with the airline for some time. Pan American's manual was not acceptable to FAA in this respect, Crothers said, and Pan American "after a time agreed partially with our conclusions" and ultimately accepted them.

Pan American's technical theory regarding the gear oscillation, as expressed by Adams at the hearing, is primarily concerned with the automatic braking of the wheels during the retraction cycle. Balance of rotational forces of the two pairs of wheels on each main gear is the primary design feature which prevents excessive pitching of the truck, Adams said.

The snubber, while it performs a desirable function, "was not an essential safety item," he said. PanAm felt that if sufficient pitching forces were set up by uneven braking, the snubber would not be able to arrest them and prevent damage to the beam.

Boeing's modifications to the jet's gear assembly were covered in a service bulletin issued last week and retrofit parts will be issued. They apply to all models of the 707. Boeing said its tests showed that unequal stopping of the front and rear pairs of wheels after takeoff could cause excessive up and down pitching of the truck beam.

Pan American Capt. Edward Sommers described in detail his landing of the 707-120 with two wheels missing on his left main gear. His takeoff appeted normal, Sommers said, and he was airborne at about 161 kt. Gear-up was ordered as soon as a definite climb was established, but he was advised by the first officer that the geardown warning lights had not gone off. Shortly after that came the tower advice that part of his gear had been lost. Sommers cruised at 2,500 to 3,000 ft with gear down, flaps down 20 deg., always VFR and always in sight of the airport. He decided to land at Idlewild because it was "home base" and "I was sure that Idlewild could do the best job." He considered foaming of the runway an added precaution but said he frankly had never seen the foam and didn't know whether it really would have helped or not. There was a lag of about 25 min. between completion of preparations and clearance to land, and his fuel was getting low. He had 10,000 lb. when he landed, enough for a go-around. He crossed the threshold at about 133 kt., a little more than would have been normal because of the cross wind and because he wanted to make a soft landing. Initial part of the landing seemed normal as far as the directional factor was concerned. He raised the spoilers, did not initially use brakes but applied all four thrust reversers. As the weight came down on the gear, the left strut dug in and the aircraft tried to turn left. He used the right brake to bring the plane back. He evidently overbraked it slightly, because it started to the right. He cut the right reversers and it returned to center. By then the landing roll was over.



GEAR of 707 is detailed above. Leveling cylinder is hidden by truck beam.

Airlines Modifying Electra Wing To Cure Skin Cracking Problem

By Robert H. Cook

Washington—Wing structures of the Lockheed Electra turboprop transport are being modified by American and Eastern Air Lines as a result of nine cases of wing skin cracks reported to the manufacturer in the last three months.

Seven of the skin breaks occurred on Eastern aircraft, one on a Western Air Lines transport and the third on a Lockheed test plane.

From 2 in. to 10 in. in length and running spanwise, the cracks appeared in the front edge of the top wing plank, which is four planks back from the leading edge, and in all cases originated directly over the large rib carrying the landing gear loads. This rib is located outboard of the No. 2 and 3 engine nacelles.

Cracks were discovered in both right and left wings, according to Federal Aviation Agency spokesmen.

Early suspicions that cracks may have been a byproduct of the Electra's vibration problem (AW May 4, p. 47) were unfounded, the FAA spokesmen said, on the basis of Lockheed stress testing and analysis. These tests indicated that the skin damage resulted from excessive wing skin tension caused by vertical loads on the landing gear which were transmitted to the wing skin.

Tests also showed that the damage was not caused by wing loadings from excessive bending and twisting in flight.

Although two of the aircraft, the Lockheed test plane and Western aircraft, were involved in hard landings which exceeded the Electra's design requirements, Lockheed says that the tests indicate that the problem of wing skin cracks is a matter of design needing correction rather than an airline operational problem.

Lockheed Tests

Lockheed factory modification to correct this problem has been to install an aluminum plate one-quarter inch thick, four inches wide and 42 in. long as a chordwise reinforcing strap over the rib cap from the middle of plank No. 2 to the middle of plank No. 6. The plate acts as a bridge to lift wing risers from both sides, preventing the skin from sagging and reducing local bending stresses to a minimum. On the aircraft which have experienced wing cracks additional doublers are now being installed.

To substantiate their belief that the damage was caused by stress transferred from the main gear, Lockheed engineers conducted tests of flight, landing and taxi loads with stress gages placed on the wings of the company's test plane.

Analysis of the results showed that vertical deflection of the landing gear support rib under landing and taxi loads caused the wing box to arch in a chordwise direction. Weight of the nacelle inboard of this rib tended to hold the wing surface down to prevent the arching and resulted in a spanwise bowing of the surface.

At the spanwise splices of the wing skin planks, the risers were lifted by the rib skin clips from only one side, allowing the skin to sag and resulting in high stresses at the point of failure.

American Modifications

American Airlines experienced no trouble with the wing skin crack problem but has made the modification recommended by Lockheed. Completed fix per plane requires approximately 30 hr. with the aircraft going to New York for the repairs.

American also has completed engine tilt modifications to seven of its 16 Electras.

Its remaining 18 Electras on order will be delivered with the modification done by Lockheed.

Tilt modification at Eastern, which is more than one third complete, requires eight days per plane and is done in the company's Miami maintenance shops.

All 33 Eastern Electras requiring this fix are expected to be modified by the end of October. Seven others will be modified by Lockheed before they are delivered.

Air-India Supported For New York Route

Washington—Air-India International won a Civil Aeronautics Board examiner's recommendation last week for a foreign air carrier permit which would extend the airline's route system from London to New York.

Examiner John A. Cannon based his recommendation on grounds that Air-India's application is both in the public interest and in accord with a bilateral agreement signed between the U.S. and India in 1956.

Air-India presently operates a fleet of 10 Lockheed Super Constellations and has ordered three Boeing 707-437 jet aircraft for delivery early next year. Initial service to New York from London is planned for March, with three round trips a week for the Boeing 707 and two round trip cargo flights utilizing the Super Constellations, the examiner noted.

The airline told the CAB examiner that it expects to achieve a load factor of at least 60% on the new service since the 1958 load factor on the India-United Kingdom routing was 62%.

TWA Registers Profit In Half-Year Report

Washington—Trans World Airlines reports net income before taxes of $3,972,000 for the first six months of 1959 as compared with losses of $11,923,000 for the same 1958 period.

In another six-month report, KLM Royal Dutch Airlines said it recorded a net loss of $573,000 in the first half of 1959 as compared with a loss of $576,000 for same period last year.

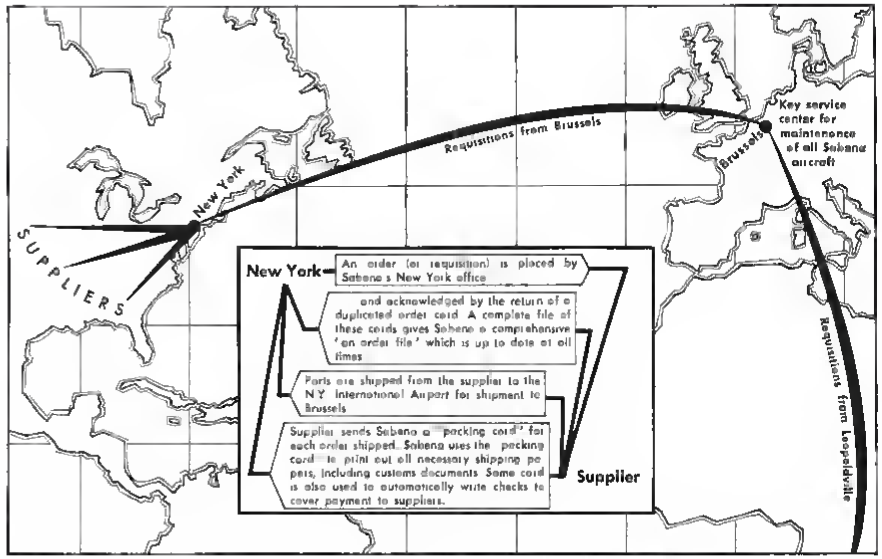
TWA had revenues of $159,306,000 for the six month period this year. After reserving $2,408,000 for income taxes the airline had a net income of $1,564,000 or 23 cents per share on 6,674,000 shares of common stock.

TWA attributed revenue gains to operations with the Boeing 707 aircraft, which have been flying with about a 94% load factor and a system-wide on-time departure record of better than 70%. The carrier also cited tighter management control over expenses.

KLM had total operating revenues of $63,574,000, operating expenses of $68,208,000 and an operating loss of $4,634,000 in the six-month period. Income of $1,083,000 from sale of aircraft and $3,538,000 released from provisions for taxes on profits, combined with a loss of $380,000 termed miscellaneous produced the $573,000 net loss figure. The airline's net loss is equal to minus 40 cents per share.

Other airline financial reports:

- **Western Air Lines** reported first half earnings of $1,894,874 or $1.87 a share on total revenues of $27,932,161. Comparing these with the first half in 1957 rather than 1958, which was drastically affected by a pilot strike, total revenues showed a 42% increase from the $19,642,761 in that period. Earnings for the first half of 1957 were $1,473,310 or $1.65 a share, but this included 56 cents a share gained from sale of property compared with only 6 cents a share from similar sources this year.
- **Mohawk Airlines** showed a first half operating income of $99,564 compared with an operating loss of $228,810 for the same period last year. Interest and other expense produced a net loss this year of $22,715 compared with a net loss of $336,962 last year. Total revenue this year for the period was $5,165,268 compared with $4,115,898 for the same period last year.



THREE-CONTINENT procurement network developed by Sabena Belgian World Airways includes radio between Brussels and New York.

Sabena Procurement Net Keyed to Jet Age

New York—Sabena Belgian World Airlines has electronically streamlined a three-continent purchasing network to meet new demands imposed by the advent of jet transports.

Sabena has five Boeing 707 Intercontinental jet transports on order for delivery late this year and early in 1960. Acquisition of this jet equipment means addition of possibly 20,000 to 30,000 items to a Sabena inventory which already includes about 100,000 different items, according to M. Curtiss Fillmore, manager of the airline's North American office, Technical Procurement Division, in New York.

Supply Pipeline

The Division Office is the operating end of a supply pipeline from New York to Sabena centers at Brussels, Belgium, the key maintenance center and Leopoldville in the Belgian Congo. Nearly everything purchased for stock shelves at Brussels and Leopoldville is manufactured in the U.S. and used on American-produced aircraft, according to Fillmore.

As an illustration of the procurement investment involved, Fillmore said that in one recent year, Sabena parts purchases for airframes, engines and spare parts totaled $22,132,598.58. In the same 12 months, about $14 million worth of parts was withdrawn from stock for use on the entire system.

To meet jet age problems, Sabena adopted Air Transport Assn. Specification 200, a standardized system involving use of common language media (such as paper tapes and punched cards) for use by the airline and its suppliers. One major difference developed by Sabena is a radio net connecting Brussels, Belgium, and the New York office, system now is in its test phase but may become standard practice.

Sabena instituted the system with one of its major suppliers, Douglas Air-

CODED tape from radio transmission is fed into IBM machine to punch order cards.

Douglas DC-8 Production Tempo Increases

Five Douglas DC-8 jet transports are lined up at Douglas Aircraft's Long Beach, Calif., plant prior to starting certification tests at Edwards AFB. Assembly of 60th airplane is under way. Planes shown here will go to Delta, Pan American and United Air Lines, five jets on line are Douglas-owned and last plane is C-133 turboprop transport. Below is first of six DC-8s which will be operated by Trans-Canada Airlines (AW Aug. 3, p. 37). Aircraft is first of production DC-8s to be powered by Rolls-Royce Conway bypass jet engines, each producing 17,500 lb. thrust. Trans-Canada plane now is undergoing flight test program at Edwards.

craft Co. and Fillmore added: "within two years we expect to have similar arrangements with all our major suppliers as well as many of the smaller manufacturing concerns and some distributors." He pointed out that Sabena has doubled its ability to process purchase orders with Douglas, through use of the system.

ATA Spec. 200 first was put into operation by United Air Lines last year in cooperation with Douglas. ATA spokesman said system takes about 18 months to reach peak efficiency.

Another innovation of Spec. 200 is streamlining of paper work so that a single card processed on an International Business Machine accounting machine can:

- Place the order.
- Obtain verification from the supplier.
- Furnish documents needed for export.
- Make payment to the supplier without any requirement for a conventional invoice covering the cost.

Here's how it works: Sabena keeps a file of punched cards for each of the parts or items supplied by a given manufacturer, in effect, a supply catalog termed Procurement Data Cards and Procurement Data Reference Cards.

Thus, when inventory analysis determines that stock levels in Leopoldville or Brussels are in need of replenishment, appropriate data cards are pulled from a master file to initiate the purchase order procedure. From this master file, order cards are forwarded from Brussels to New York, either by company punch or by the Brussels-New York radio net.

Data filed by radio arrives in New York where it is converted into a tape. The tape is simply fed into an IBM machine and is converted to a punched card for transmission to Douglas again either by mail or in case of AOG number (referring to "Airplane on Ground"), by tape, to speed the service.

Fillmore pointed out that each batch of requisition cards is covered by a control card to safeguard against errors and to provide the authorizing signature codes. A new control card is sent to the supplier, who merely duplicates the one received and sends it back to the Technical Procurement Officer, there is no form to be made out or letter written.

When the supplier ships the item to Sabena's air cargo facility, or to a sea shipping agent, a packing card is sent to the Division Office to record specific data of the shipment and develop the necessary export documents, an item of significance to Sabena, which operates exclusively overseas.

Use of accounting machines in Spec. 200, Fillmore emphasized, has produced an important airline procurement by-product, a supply-dollar committment report. System can, in a short time, provide data to management on:

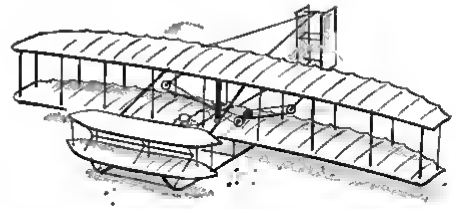
- Dollars committed per supplier.
- Dollars by type of part.
- Total number of parts and orders involved.
- Total number of orders placed with each supplier.

In addition, overdue orders can be followed up quickly as an automatic procedure, eliminating the usual "troubleshooting" roles given to supply personnel.

Fillmore said the new system has enabled the Division Office in New York to increase its work capacity by about 100% without a staff increase. System also allows Sabena to keep its fleet at peak performance from the viewpoint of safety and efficiency with a minimum practical dollar level of inventory, he explained.

Sabena's fleet, which requires this three-continent maintenance support now consists of 30 four-engine transports, and a similar number of twin-engine planes, in addition to training aircraft and a helicopter service. The planes service 104 cities in 38 countries.

Announcing...



The most important advance in aircraft oils since "Kitty Hawk"

It's the world's first non-ash, fully compounded dispersant aircraft oil to be marketed for both large and small piston-engine aircraft. This oil has *multi-viscosity* characteristics which reduce the need for seasonal grade changes.

Prior to the development of AeroShell® Oil W, all fully compounded aircraft oils had these two disadvantages—(1) pre-ignition and (2) spark-plug fouling—that were caused by the formation of ash deposits in the combustion chamber.

Now—for the first time, a completely *non-ash*, fully compounded aircraft oil is available for all piston-engine aircraft.

Performance of AeroShell Oil W is superior to that obtained with the best straight mineral oils. AeroShell Oil W has been extensively flight-tested in a wide range of engines and the results show—

1. Significant reduction in oil consumption.
2. Reduced parts wear...increased engine life.
3. Cleaner engines—practically eliminates oil screen and filter deposits.
4. Easier starting and faster warm-up.

Already four airlines have converted their entire fleet operation to the use of AeroShell Oil W.

We will be glad to give you complete information on AeroShell Oil W—the most important aircraft oil advance in 56 years.

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SHELL

AIRLINE OBSERVER

► New stewardess and purser contract recently signed by Pan American World Airways is expected to set the pace for union negotiations on other airlines. Transport Workers Union of America won for its members the highest rates for stewardess and purser flight service in the industry plus a provision for severance pay. Retroactive to Dec. 1, Pan American stewards and stewardesses will draw a starting monthly rate of $285 for piston aircraft and $328 for jets. A second increase scheduled for this December will boost the figures to $301 and $346. Also in December, employes with more than 30 months of service will draw $419 a month for piston and $482 a month for jet aircraft. Purser salaries now range from a beginning rate of $417 and $480 for the two types of aircraft and increase to $438 and $504 in December, with a maximum pay after four years of $528 for piston aircraft and $607 for pure jets.

► American Airlines reports that its jet fleet of Boeing 707-120s and Lockheed Electras carried almost half a million revenue passengers during the past six months of this year. The 707s carried 217,000 passengers more than 462 million passenger miles during the period for a sustained load factor of more than 90%. Over the same period, the company's Electra fleet carried more than 253,000 passengers an estimated 174 million passenger miles, with an over-all load factor of about 80%. The two types of aircraft, which make up only 17% of American's 138-plane fleet, accounted for 36% of the carrier's total passenger miles in the six month period.

► United Air Lines has signed interline traffic agreements with Polish State Airlines and Hungarian Air Transport. Pacts provide passenger travel or cargo shipment over United routes and those of the two Soviet satellite carriers by issuance of a single ticket or air waybill. United previously signed similar agreements with Czechoslovakian Air Lines and Yugoslav Airlines.

► Federal Aviation Agency has issued a notice of proposed rule-making that would add two new jet routes in the Southwest and East. The first would extend Jet Route No. 58 from Dallas to New Orleans, bypassing a heavy concentration of military traffic in the vicinity of Chennault AFB, Lake Charles, La. The second would establish a new jet route between Spartanburg, S. C., and Gordonsville, Va.

► New five-year Air Express agreement has been signed between the scheduled airlines and the Railway Express Agency. Now being formally prepared for submission to the Civil Aeronautics Board, the agreement is considered a "major improvement" by both airline and Railway Express spokesmen who point out that cost plus features are being eliminated in favor of a mutual sharing of gross revenues and equal rights for both parties in rate matters and other operating phases.

► Belgium's Sabena and Russia's Aeroflot airlines carried a combined total of slightly more than 4,000 passengers between Moscow and Brussels during the first year of direct air service linking the two capitals, according to Sovetskava Aviatsiva, Soviet air force newspaper.

► All Nippon Airways plans to order two Sikorsky S-55 helicopters from Mitsubishi Heavy Industries Reorganized, Ltd., which manufactures the helicopter in Japan under license. Delivery of the first machine is expected by early next year. All Nippon spokesmen say the S-55 will be used for short range transport and that their purchase represents a first step toward company adoption of large helicopters, possibly the Sikorsky S-58, for future operations.

► Financial firm of Walter E. Heller Co. is providing approximately $500,000 for a used aircraft transaction handled through the Aircraft Exchange. Deal involves two Douglas DC-4s purchased by Seven Seas Airlines from Twentieth Century Airlines. Heller is a member of the exchange and the first financing source to be tapped through this service. The aircraft are to be used in charter work. Heller is primarily a factoring organization, which provides cash to a company by taking over its receivables, but also has other financial interests.

SHORTLINES

► American Airlines is scheduled to inaugurate air mail service on its Boeing 707-120 jet flights between Dallas and Los Angeles on Aug. 14. Effective Aug. 21, air mail will be carried on American's 707s between Boston, Chicago and San Francisco and Chicago and Dallas.

► British Overseas Airways Corp. carried 13,254 eastbound passengers on its U. S.-Europe routes in June for a load factor of 87.5%. Load factor breakdown was 85.8% in first class, 77.1% in tourist class and 91.7% in economy class. Passengers from Europe to the U. S. totaled 6,612. BOAC's eastbound transatlantic cargo for June was 212,964 lb.; mail for the route was 23,942 lb. Passengers carried by the airline from Canada to Europe totaled 3,842 eastbound, 2,975 westbound.

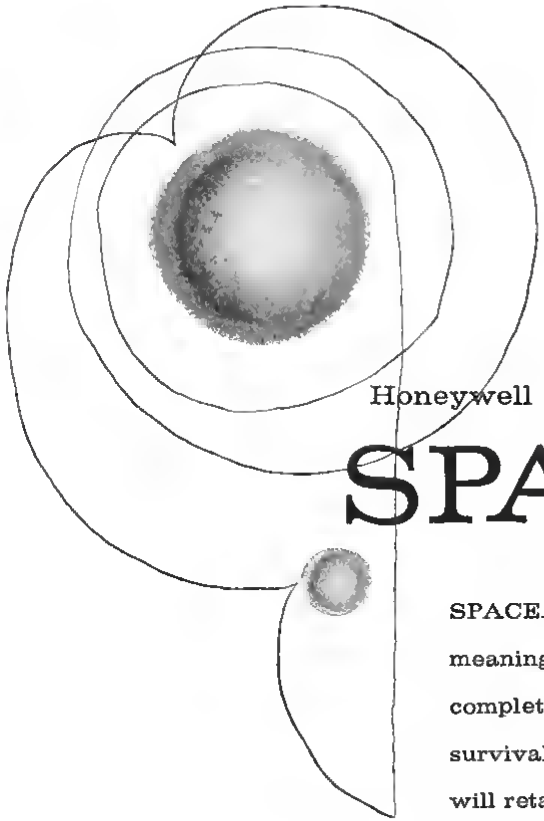
► Eastern and United Air Lines have linked their 81,524 mi. of private line teletype to expedite interline reservations. Eastern has similar communications with four other carriers. United with five others. Eastern's package vacation tours have shown an over-all increase of 27% in sales during the first six months of 1959 as compared with the same 1958 period. Principal gains have been in the Florida, Caribbean and Mexico markets with Puerto Rico and the Virgin Islands showing the largest percentage gains.

► Iberia Air Lines of Spain reports that its eastbound transatlantic load factor for the month of June was approximately 92%.

► Lake Central Airlines has added four new daily round-trip flights on its system to increase its service by 15%. Included are an additional round trip on the Indianapolis-Youngstown route, an additional round trip on the Indianapolis-Chicago route, an additional round trip between Indianapolis and South Bend and a new round trip between Cleveland and Columbus.

► National Airlines reports a 65.1% system-wide increase in package vacation sales for the three month period ending July 15 as compared with the same period of 1958.

► Seaboard & Western Airlines has moved into its new three-story headquarters building at New York International Airport. The structure houses the cargo carrier's executive and administrative offices and covers a 2.8 acre site on the airport's main road. Sales department offices will remain at 80 Broad St. in downtown New York.



Honeywell calls it

SPACEABILITY

SPACEABILITY is a new term meaning the capability to completely equip man for survival in space. While he will retain the ability to exercise his judgment with manual controls, man's welfare in space will depend largely on automatic control of his navigation, flight and power—in fact, his total environment, including food, oxygen and waste disposal.

There are three areas indispensable to space operations: (1) motion control and navigation for vehicles of flight, including inertial systems, (2) environmental control for human activity, and (3) instrumentation and data processing both on the ground and in the air.

Recognition of Honeywell leadership in all three areas is exemplified by the fact that Honeywell controls are going into almost all space vehicles presently planned.

This Honeywell capability is benefiting the following projects, some of which have already been completed:

- Providing complete guidance and flight control system for Project Scout, the NASA launching vehicle for orbital and probe flights of instrumentation satellites.
- Developing navigation and guidance system for the proposed Martin version of Dyna-Soar, the Air Force pilot-controlled semi-orbital vehicle.
- Developing and producing an advanced space cabin environment simulator for the Air Force School of Aviation Medicine.
- Supplying orbital injection guidance reference systems for Project Vanguard's launching of satellites into predetermined orbits.
- Developing and producing attitude control for both orbiting and re-entry versions of Project Mercury, the NASA manned satellite program.
- Developing and producing attitude stabilization systems for vehicles used in re-entry test phases of Project Mercury.
- Human engineering studies and instrumentation development for pilot orientation in space flight for Project Mercury.

Corporate capability—With a notable background in missile and space systems management as well as in the design, development and production of systems and components, Honeywell is fully qualified for work on all phases of prime missile and space systems.

Human engineering in relation to space flight is being studied by an entire project team at the Military Products Group's aeronautical facility in Minneapolis. The group is made up of specialists in anthropology, anthropometry, bio-chemistry, bio-physics, psychology and psycho-servo analysis. Their goal: optimum integration of man into a complex control system, which involves problems such as efficiently dividing labor between manual and automatic computation equipment.

Honeywell organization makes available to space projects unique capabilities and experience. These include Industrial Instrumentation, Computing and Recording complex, the services of environmental experts in the Temperature Controls Group, and associated members of the Military Products Group, Ordnance, Aeronautical, Boston, and Missile Equipment Divisions. The Corporate Research Center works closely with all groups.

Areas of interest and activity at Honeywell for space projects include the following:

Inertial guidance and navigation systems, gyros, stable platforms, accelerometers, computers, air data systems, ballistic trajectory control systems, horizon scanners, fix takers, reaction jets, control valves.

Other areas are flight data sensing and display systems, telemetry and recording systems, data reduction systems, pressure and temperature sensors, analog-digital and digital-analog converters, atmosphere composition control systems, temperature control systems, pressure control systems and recording devices.

If you have a problem that requires outstanding capability in control for space projects, call on Honeywell. For information write Honeywell, Minneapolis 8, Minn.

Honeywell

Military Products Group

Hughes Takes Cautious Space Approach

By Russell Hawkes

Culver City, Calif.—Cautious step by-step advance into the field of space technology characterizes the research projects of Hughes Aircraft Co.

Dr. Rex C. Mack, manager of advanced planning in Hughes' Systems Development Laboratory and ex-officio coordinator of space technology, contends that premature projects and poor logic have inflated the cost of space technology programs out of proportion to the results.

The Hughes idea is that solid achievements in space technology can only be based upon the careful accumulation of research information and improvements upon the tried methods of missile and aircraft technology. Work is upon a more conservative scale than that of some of the other major manufacturers in the space flight business.

Hughes has only about 50 scientists and engineers assigned to space projects on a full time basis. Other talent is drawn as needed from functional design groups elsewhere within the organization. The total number of professional persons thus employed seldom exceeds 100.

Advanced Projects

Despite the company's emphasis upon today's space technology rather than that of tomorrow, the company lists two advanced projects—a space ferry and atomic clock. The first of these is a space ferry design study being carried out in conjunction with Lockheed Aircraft Co. Hughes has responsibility for control and guidance. Thus far the program has been carried on with Lockheed and Hughes money, but the study phase is nearing completion and Hughes believes the next phase of work will require government support, since it would probably involve the construction of test models and breadboard avionics.

The proposed space ferry would carry a payload of several tons into an orbit of between 100 and 1,000 mi. altitude and effect a rendezvous there with an orbiting space station. Hughes says that tuning of further development is the only remaining issue.

Hughes and Lockheed are not attempting to specify the missions for which the space ferry might be used. The ability to make a precise rendezvous with an object in orbit suggests several possibilities. Most obvious use would be for the construction, supply and maintenance of stations in space.

Dr. Mack believes that such a space ferry probably could be delivered in 1965 if the necessary financial support is forthcoming. He reports that the task is largely within the present state of the art. Main lack is some actual experience in human reactions to the space environment. Dr. Mack said Project Mercury should provide an ample base for continued development.

The project has been underway for about nine months. Lockheed has a preliminary design airframe nearing completion and Hughes has laid out simulator programs for control problems to be expected throughout all the anticipated mission profiles. Dr. Mack says that control in most mission phases would be fully automatic as it is in ballistic missiles, but that a redundant manual override system would be provided to allow the crew to cope with unforeseen eventualities. Control would definitely be manual during last few hundred feet of the rendezvous and probably will be manual during the final approach and landing after re-entry.

The space ferry system is predicated upon the availability of one of the up-

Model Nose Cone Used for Systems Checkout

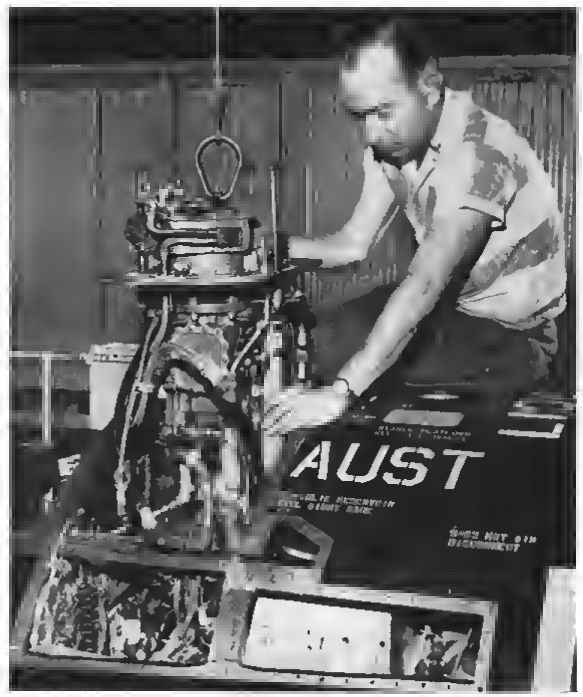
Full-scale model of Atlas intercontinental ballistic missile nose cone has been built by Avco Corporation's technicians to allow checkout of internal components through transparent skin. Visible equipment is part of telemetry and re-entry stabilization systems.

coming big boosters. Lockheed has not yet settled upon a selection.

Hughes has found that re-entry, as always, sets the most critical control parameter. Variations in the re-entry attitude program can strongly affect aerodynamic heating rate and can move the landing point along the course line by distances of 500 or 1,000 mi. Hughes engineers believe they will probably use jet reaction controls for trim during the re-entry phase as well as for primary control.

For missions of longer duration than those now foreseen for the space ferrys, Hughes engineers believe that acceleration of flywheels or precession of massive gyroscopes would be more attractive for rapid short term adjustments in attitude. Experiments have shown that these devices are rapidly saturated and Hughes is aware that it would be necessary to desaturate these periodically by the use of jet controls. However, the jets could operate at their most efficient points.

Hughes has treated the navigation problem in essentially the same manner as that of an interceptor missile guidance problem. No position reference would be needed aside from that provided by the orbiting rendezvous target and an inertial platform within the space ferry to derive present position for the solution of the intercept problem. To aid use of the rendezvous target as a navigation reference, or homer, some form of cooperative system would definitely be used. The infrared or radio beacon within the orbital rendez-



X-15 Hydrogen Peroxide Power Unit

Hydrogen peroxide-powered auxiliary power unit, developed by General Electric, is lowered into North American X-15 prior to recent glide test. Each of the two units used in the X-15 has a specific fuel consumption of 10.6 lb./hp./hr. and produces 4 kva. of 400 cps a.c. electricity and 16 gpm. of 3,000 psi hydraulic power. Operation cycle is up to 30 min., during which the two APUs produce all the electric and hydraulic power required to operate 1,300 lb. of instrumentation, heating elements in the pilot's pressure suit and throughout the X-15, the inertial guidance system and its computers, communication, telemetering and recording equipment, speed brakes, landing flaps, and control surfaces.

vons target would be powered by batteries or perhaps by solar cells for unusually long duration missions.

Hughes and Lockheed believe that at first the ferry should be as simple a vehicle as possible and that roles and missions should be assigned at later dates when more is known about the problem and when some experience has been accumulated with possible solutions. The navigation system should be a logical extension of the all-weather fire control system and interceptor missile guidance system techniques with which Hughes has considerable experience.

Hughes' second advanced project is the well-publicized test of Einstein's general theory of relativity by comparing the output of a highly stable Maser oscillator in orbit with that of one or more upon earth (AW July 6, p. 26). Oscillators would serve as clocks to measure time dilatation.

Hughes Aircraft holds a contract for $200,000 from National Aeronautics and Space Administration for the development of an experimental Maser clock for this project. The clock is expected to weigh about 30 lb. complete with batteries for a running time of three weeks and to occupy about one-half cubic foot in volume. It is to have an error of only about one second in a thousand years.

Satellite Orbit

With the necessary stable time references available, NASA is expected to proceed with the satellite vehicle and other necessary equipment. The satellite will orbit at an average speed of about 18,000 mph. and an average altitude of about 8,000 mi. It will periodically telemeter the time count of its Maser clock to a ground station where it will be compared with a similar clock at that station. It is possible that the clock satellite will transmit only at perigee to reduce noise effects which accumulate with range.

According to the general theory of relativity, the Maser clock in the satellite should run slow, compared with the ground clock, for orbits below 2,000 mi. and fast for orbits above 2,000 mi. According to Dr. Harold Lyons, head of the Hughes Atomics Physics Department, this is because the relativistic effects of motion predominate below 2,000 mi. while the effects of gravity difference predominate above. The effects are of opposite sign and cancel at 2,000 mi. so that a clock in an orbit at this altitude and one on the ground would agree. At the 8,000 mi. height, the two clocks should differ by about one second in 60 years. A quantative check of both special and general theories of relativity can be made by means of flights at various altitudes.

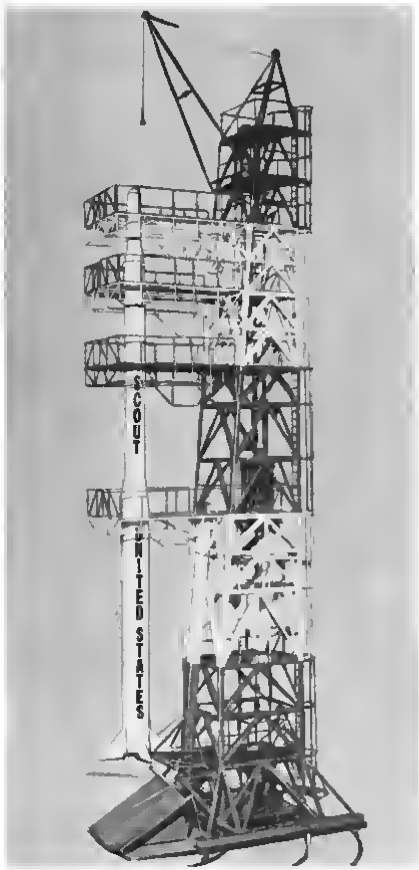
According to the special relativity theory a clock should slow to zero as it approaches the speed of light. General relativity theory on the other hand shows that passage of time is controlled by the gravitational field about the phenomenon or clock by which time is measured. Electromagnetic frequencies radiated appear to be lowered in a stronger gravitational force so that any light which an earth-bound object might emit would tend to be redder than that from a similar light source in a high orbit. This gravitational effect has been called "the red shift."

A clock in an orbit about the earth conversely appears to be speeded up due to the fact that the gravitational attraction of the earth is less at the orbital altitude. Light emitted in the satellite trends toward the ultraviolet end of the spectrum—an effect called the "violet shift."

Investigations of the Maser have been going on at Hughes Research Laboratories for about four years. Dr. Lyons invented the original atomic clocks while working for the U. S. Bureau of Standards. The ammonia Maser clock to be used in the satellite experiment was invented by Prof. Charles H. Townes of Columbia University.

The relativistic clock experiment has been proposed often in the past. It was

Chance Vought Aircraft, Incorporated, Announces Five New Divisions



VOUGHT INTEGRATING 70-FOOT ROCKET. This four-stage *Scout* space research vehicle is being readied by Chance Vought for NASA use. Vought was chosen over 12 other firms for the *Scout* development contract.

MORE THAN 500 ALREADY DELIVERED. *Crusader* fighters, grouped for delivery on this Chance Vought flight ramp, have been deployed in three different versions with the U. S. Navy and Marine Corps.

Chance Vought is pleased to announce the formation of five new divisions, effective August 1, 1959.

These divisions will point their activities toward technological fields that have become Space-Age specialties: Astronautics, Aeronautics, Electronics, Range Systems, and Research.

This realignment is the result of considerable study, both of company capabilities and of new business opportunities. It is an effort to bring all of Vought's scientific/technical abilities and facilities to bear on the challenges and opportunities in the Space-Age future.

At the same time, the new structure has strong provisions for expanding activities that are traditionally basic at Chance Vought — such work as the advancement of manned aircraft design and production, pioneering in the human factors of flight, and aeronautical research.

ASTRONAUTICS DIVISION

Chance Vought is taking fullest advantage of its existing capabilities to obtain broader responsibilities in astronautics. Concentration will be on advanced vehicles for space exploration, and on ballistic and anti-ballistic missile systems, where the company will draw on 12 years' experience in the missile field.

Vought's first contract work with space hardware — integration of the *Scout* space rocket — is under way. The company is readying this research rocket and its launcher under a National Aeronautics and Space Administration contract.

Also, Vought and other members of the Boeing team are participating in the development of the *Dyna-Soar* boost-glide vehicle in competition for an Air Force contract. And in the human factors of space flight, Vought is already taking the lead with its orbital flight simulator and space-oriented cockpit laboratory.

AERONAUTICS DIVISION

Traditionally a vital field at Vought, aeronautics will see continued emphasis on design advancement. Scope will be broadened beyond manned aircraft to include a new generation of atmospheric missile types, antisubmarine systems, support systems and subcontracting.

Current contracts in this division include production orders for three versions of F8U *Crusader* series aircraft, study contracts in ASW, subcontracts for military and commercial aircraft assemblies, a Navy contract for development of an environmental protection and escape capsule for aircraft pilots.

ELECTRONICS DIVISION

Vought electronics will be developed, manufactured and marketed in increasing volume. Military systems under development include antennas and related electronics, ground support electronics and antisubmarine warfare apparatus. Technical and laboratory support of other company divisions will be a continuing task in Electronics.

RESEARCH DIVISION

Basic research aimed at generating new knowledge is this division's function. A new Research Center will provide creative environment for basic research. This work — as it evolves into applied research — will materially support all other divisions. Extensive facilities, including wind tunnels and a high-temperature lab, will be at researchers' disposal. Fields of research include astronautics, undersea warfare, nuclear studies, sea resources, the life sciences and electrogravities.

RANGE SYSTEMS DIVISION

Twelve years' experience in remote base operation qualifies Vought for additional business in a very new field — establishment and operation of test ranges and test equipment for missiles and space vehicles.

Genesys Corporation, a wholly owned subsidiary company, was formed in May of 1958 to intensify Vought's diversification into commercial electronics. Company emphasis is on automation, and its key personnel are engineers experienced in the fields of electronics, computers, magnetic memory, and other associated electro-mechanical devices.

AERONAUTICS · ASTRONAUTICS · ELECTRONICS · GENESYS CORP. · RANGE SYSTEMS · RESEARCH

CHANCE VOUGHT
DALLAS, TEXAS

ton difficult to carry out until atomic clocks became available and rockets and satellites were developed to put the clock in orbit.

NASA is financing this project upon the recommendation of the Space Science Board of the National Academy of Sciences.

The Maser clock uses the vibrations of ammonia molecules at an unvarying 24,000 mc as a time reference. The nitrogen component of the ammonia used in the Maser is the stable isotope nitrogen 15 sometimes used as a tracer in agricultural research. It is available in large quantities at about $400 a gmm. Nitrogen 15 ammonia is used in the Hughes Maser because it is a far more stable frequency reference than other forms.

Lyons says, "Other features of the Hughes design which provide accuracy or other performance benefits are a frequency divider and servo circuits of the phase-lock type, a highly stable double resonant cavity, temperature stabilization, precision cavity tuning method, a unique source for generating the ammonia beam and a parametric diode frequency multiplying circuit. The double cavity system greatly reduces reaction of the Maser output system on the ammonia molecules and eases the temperature control problem, while the cavity tuning method likewise provides a great reduction of possible interaction.

"Parametric circuits using gold bonded germanium diodes make it unnecessary to use any electron tubes in the Maser clock circuits, thus greatly cutting down on battery weight. Ultimately the entire electronic circuitry will be transistorized making the clock rugged and light. Other Maser advantages are its relative insensitivity to magnetic fields which will be different at the surface of the earth and in orbit, its relatively rugged design and the fact that it is the only atomic clock which generates its own time signals.

"When the relativistic clock satellite experiment is done, it will be possible to conduct additional experiments on geophysics and velocity of light without adding equipment to satellites. We would like to see another clock-equipped ground station set up so that the satellite clock time signals could be received at both stations. The relativity measurement will automatically give the time the signals take to get to the stations, so that by methods of triangulation the distance between the stations could be measured in terms of the known velocity of radio waves.

"Such measurements would give exact geometric shape of the earth and could be made over inaccessible regions such as water or mountains. Present orbital measurements of satellites

give the mass distribution of the earth rather than its geometric figure. This experiment can be reversed and the velocity of light measured in terms of the distance between ground stations. This could be done in different directions in space over paths of thousands of miles, thus checking on whether space is isotropic. The velocity of light could be measured for different satellite speeds, showing that it is independent of the motion of the source, as relativity requires."

Ultimately, Hughes hopes to get Maser oscillators with frequencies stable to one part in 100 billion. These highly stable oscillators would make possible far more accurate doppler navigation systems. Stable oscillator-based transmitters could be located upon the ground or in satellites and very small doppler shift would be very easily measured.

The oscillators could also be carried in the aircraft. Hughes is proposing such a system to the military services and to NASA.

Radiation Belts

Hughes also has proposed to Air Research and Development Command a theoretical investigation of the Van Allen radiation belts using relativistic techniques to determine such things as the relationship between the belts and their predictability.

One of the many smaller and more immediately practicable space technology projects at Hughes is the packet re-entry system. This is a subsystem designed for the return to the surface of the earth of a large number of instrument packages or other capsules from a single satellite. These could be ejected in a controlled sequence for such purposes as laying down a network of weather observation capsules to get almost simultaneous weather data all over the world. This synopsis of world weather made possible by several satellites using the packet re-entry system should prove to be very useful for research into the general circulation of the atmosphere, leading to better weather forecasting procedures, officials contend.

Re-Entry System

Hughes has been working in the packet re-entry system for only a few months. For analytical purposes scientists have designed a 35 lb. capsule with a payload of 5 lb., divided into eight 10-oz. packets, each with its own retro boost system. Informal presentation has been given to NASA and to the military services. Hughes says the packet re-entry system is available anytime one of the agencies finds a requirement for it. System will be standardized for off-the-shelf sale.

This involves considerable inaccuracy because of the variety of possible instrumentation packages that could be used in these packets. Despite this, Hughes believes impact areas should be predictable with an error on the order of no more than 75 mi. Beacons in the packets could easily have that much range to permit final location and recovery by search teams.

Hughes Aircraft has been active in studies of communications satellites for about a year, and work has been in the field of concept as well as in the instrumentation packages themselves. Most interest in the industry has centered upon the so-called 24-hr. communications satellite which remains essentially fixed over a point in the equator since at its orbital altitude, it would have the same 15 deg. per hour angular velocity in its orbit as a point upon the surface of the earth.

A drawback to the 24-hr. communications satellite is that communications from the satellite to the surface of the earth would be poor for surface stations within 10 deg. of the Pole. Hughes is interested in a communications satellite serving primarily the northern hemisphere which would have a high coincidence with the apogee north of the equator. Keplerian mechanics dictate that such a satellite would be over the northern hemisphere during as much as 90% of its orbit.

Hydrogen, Hot-Shot Tunnels Record Heat

Canoga Park, Calif.—High temperature physics research is being conducted here using facilities built for the Aero Ballistics Laboratory, Army Ballistic Missile Agency, under a U.S. Army Ordnance contract. Three high temperature high speed wind tunnels—two hot shot types and one hydrogen gun type—are being operated by Rhodes & Blowsom Applied Physics Research laboratory. Fourth facility, under a separate contract, is used to investigate controlled fusion for application to a gaseous reactor rocket engine.

Among other experiments, Jupiter [illegible] tests have been run in a 12 x 12 in. hot-shot tunnel having 48,000 joules energy capacity. Unique features of the hot-shot unit are the following:

• **Square test section** and source flow nozzle which permits any desired Mach number and Reynolds number to be obtained by moving model up into the source flow nozzle.

• **Force measurements** in the tunnel are made by suspending the model, weighing a few grams on a .005 copper wire. Precision measurements of 1% within one millisecond are possible by graphical integration of acceleration compared to a film record.

• **Extreme purity level** of the gases in the hot shot is possible because electrode erosion is 100 times less than in other hot shots absolute level being less than 1 milligram or .04% of the gas mass at 8,000K. This low impurity level permits spectroscopic measurement of the temperature by means of a two color gray body intensity ratio.

Second facility developed under the Army Ordnance contract is a hypervelocity hydrogen gun also operated by a 48,000 joule capacitor bank. A 10 microsecond discharge time is possible using one half inch nylon models which move at 10,000 to 15,000 fps. As in the hot-shot, low impurity levels are possible because of the short discharge time and large electrode surfaces. Rhodes & Blowsom is presently experimenting to obtain escape velocities with a known model shape in this hypervelocity tunnel.

Continuous hot shot tunnel, which operates for 20 sec., also is in operation. Tunnel operates at pressures of 2 to 5 psig. at air temperatures of 11,000K. This is a battery-operated, stabilized arc air heater which operates on 220 kw power input. A two throat system is used which permits temperatures to run below 2,000K.

Carbon impurity levels are below 100 parts per million throughout the range currently studied.

Marquardt

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FOR AIR AND SPACE

UNIQUE MARQUARDT CONCEPT SHRINKS EARTH TO 14-FEET

Advanced land mass simulation concept demonstrates Pomona Division capability in realistic simulators for lower-cost training of America's air and spacemen.

IN DEVELOPMENT:

A Marquardt-conceived land mass simulation system that shrinks the map scale factor to 1/3,000,000, while enabling the operator to distinguish landmarks smaller than a football field from any altitude! Application today: ground-training airmen for intercontinental missions at great savings in cost—using a single 8-foot map to realistically simulate the radar reflectivity and shadow effects of a 4,000-mile mission. Application tomorrow: training the free world's first space explorer for his safe return to earth.

IN PRODUCTION TODAY:

Pomona Division's AN/GPS-T4 Radar Signal Simulator, a relatively low-cost training system that is simple, compact, flexible and realistic, producing synthetic target and IFF video information for radar display. Current mission: training USAF aircraft controllers to direct interceptor missions. Ready adaptability will permit the T4 to simulate missiles, radar surface targets and sonar targets.

IN THE U.S. DEFENSE INVENTORY:

The USAF's AN/APQ-T1, AN/APG-T1A, AN/APQ-T2 and T2A, and AN/APQ-T3 simulator-training systems, plus the USN's 15WV-2 AEW/CIC trainer system—all developed and manufactured by the Pomona Division and its predecessor companies. Numerous sub-systems, up-dating modification kits, adapters, spares, and a worldwide field service section add to the organization's total experience.

POMONA DIVISION of The Marquardt Corporation is an able and experienced organization with demonstrated capability in advanced research, design, development and production. The result is reliable hardware which provides solutions to the problems of training military operational personnel.

Drawing on the Corporation's overall management-engineering skills, additional facilities and financial support, Pomona Division now offers industry and the Armed Forces a unique and proven ability to get the job done—delivering vital simulator-training system both on-time and at minimum cost.

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Engineers and scientists capable of contributing to advances in state-of-the-art are invited to write to Dr. Wendell B. Sell, Vice-President.

A 11

MASSIVE 18 ton centrifuge checks operation and ruggedness of guidance systems developed by Massachusetts Institute of Technology.

MIT Sparks Inertial Guidance Efforts

By Philip J. Klass

Cambridge, Mass.—Many of the techniques and devices which spawned today's multi million dollar-a-year inertial guidance industry were conceived here in an obscure, aging brick building which once housed a boot polish factory. The facility, known as the Massachusetts Institute of Technology Instrumentation Laboratory, is directed by Dr Charles S Draper who also heads MIT's Aeronautics and Astronautics Department

The inertial guidance system designed to direct three of the nation's long range ballistic missiles to their targets—the Thor, Titan and Polaris—had their origin here at the Instrumentation Laboratory on the edge of the MIT campus

Less than 15 years ago, Draper and a handful of associates were among the few who were optimistic enough to believe that they could achieve the near-fantastic improvement in gyro drift rate and accelerometer sensitivity required for a practical inertial guidance system, in a size, weight and at a price which would permit its use in aircraft and missiles. There were a few other such optimists at North American Aviation and in Army Ordnance

DR. CHARLES S DRAPER

The floated integrating gyro, which opened the way to orders of magnitude reduction in gyro drift rate and which now finds use on most inertial systems, came out of the Instrumentation Laboratory, as did the widely used pendulous integrating accelerometer. A mathematical approach to computing ballistic missile guidance commands, which permits major simplification of the missile's computer is credited to Dr J H Laning of the Instrumentation Laboratory

Because the bulk of the laboratory's efforts have been government-sponsored the resulting techniques and devices have become available to industry. More than half a dozen companies today are producing the floated integrating gyro originally conceived by MIT. The gyro also finds wide application in fire control systems

The Instrumentation Laboratory has served as the development facility for the inertial systems which AC Spark Plug Division of General Motors is producing for the Thor and the ones

it will manufacture for the Titan. MIT designed the inertial system which General Electric is assembling for the Navy Polaris IRBM. The original Ship's Inertial Navigation System (SINS) for ship submarine use also came out of this laboratory.

This important contribution to the nation's inertial guidance know-how has come from government funding which has averaged only approximately $4 million per year since the end of World War II. The funds available in the early postwar years were considerably less than this average. This year, the Instrumentation Laboratory operations will cost about $14 million, which includes work in areas other than inertial guidance.

Originally the Air Force sponsored the bulk of the laboratory's work in inertial guidance. Today the Air Force picks up the tab for about two-thirds of the operations, with the Navy covering the balance. All contracts are of a cost-reimbursement type without any fee because the laboratory is operated on a non-profit basis.

Laboratory Staff

At present the laboratory employs slightly more than 800 persons, of which nearly 300 are professional engineers and scientists.

The Instrumentation Laboratory plays another function which Draper believes is equally important to its more familiar one. This is education. Under Dr. Walter Wrigley, educational director, the laboratory conducts classified courses in inertial guidance for military personnel, and unclassified courses for MIT graduate students. This enables MIT to give students a good grounding in both theory and practical design aspects of inertial guidance using professors who are practicing the latest state of the art. This is important in a fast-moving technology.

MIT also has a program whereby industry engineers can come in as teaching assistants and enroll in inertial guidance or other MIT courses. The engineer's company pays his salary. Companies that have participated in the plan include AC Spark Plug, General Electric and Minneapolis Honeywell Regulator Co.

The Instrumentation Laboratory, which took its present name in 1946, is a descendant of MIT's Confidential Instrument Development Laboratory, formed in 1940 to work on naval gun directors. The latter was an outgrowth of a small Instruments Laboratory, headed by Draper, which worked on aircraft instruments in the mid-thirties.

The computers which had been designed prior to World War II to direct shipboard guns against other ships proved too slow and cumbersome for use against attacking aircraft. Draper and his associates conceived and developed an extremely fast, small and simple gunsight which used a spring-restrained, viscous-damped rate gyro which proved far more effective for anti-aircraft use. This gunsight, known as the Mark 14, became a Navy standard and more than 100,000 were produced by industry.

Soon afterward the same basic technique was applied to a gunsight for use in aircraft. This gunsight, officially known as the A-1, sometimes is called the "Draper-Davis sight." Draper's collaborator was Col. L. I. Davis, now a major general, who had done graduate work under Draper at MIT in 1940 and at the time was chief of the Armament Laboratory at Wright Field.

From these original designs came an entire series of improved shipboard fire control systems, and the A-4 gunsight which gave the North American F-86 such a sharp edge over superior numbers of Soviet MiG fighters in Korea.

Fire Control

Near the close of World War II, the Instrumentation Laboratory turned its efforts to bomber defense fire control and interceptor fire control systems. The tail defense system used on the Convair B-58, manufactured by Emerson Electric, is an outgrowth of an MIT development. The Instrumentation Laboratory also was one of the first to successfully flight test a fully automatic interceptor fire control system in which the radar computer controlled the interceptor's flight path directly through its autopilot, by-passing the human pilot.

Research Philosophy

Displayed in a prominent position in Dr. C. S. Draper's office in the Instrumentation Laboratory, although not originated by him, is this philosophy of research: "Research is a gamble. It cannot be conducted according to the rules of efficiency engineering. Research must be lavish of ideas, money and time. The best advice is don't quit easily. Don't trust anyone's judgment but your own, especially don't take advice from any commercial person or financial expert.

"And finally, if you really don't know what to do, match for it. The best man to decide what research work shall be done is the man who is doing the research. The next best man is the head of the department. After that you leave the field of best persons and meet increasingly worse groups. The first of these is the research director who probably is wrong more than half the time. Then comes a committee which is wrong most of the time. Finally there is the committee of company vice presidents which is wrong all of the time."

This extensive background in gyros, servomechanisms and stabilization was a major factor which directed the laboratory's efforts into inertial guidance shortly after the end of the war. Another was the return of Dr. Wrigley from Sperry Gyroscope Co. In 1940, Wrigley had obtained his doctorate at MIT with an investigation of methods for indicating the direction of vertical from moving bases—a cornerstone of inertial guidance.

Although radar had proved a great boon to high-level, all-weather bombing in World War II, it had the important disadvantage of emitting electromagnetic radiation which alerted the enemy of impending attack and which could be jammed by enemy electronic countermeasures.

For these reasons, USAF's Armament Laboratory was anxious to find another approach to bombing-navigation system design which would not use tell-tale radar. The Instrumentation Laboratory tackled the job with the idea of using a combination of inertial and celestial techniques, since it did not then appear possible to obtain the component accuracies needed for an all-inertial system. The result of this program, known as Febe, weighed 4,000 lb. and was completed in 1948.

All-Inertial System

By this time, the Instrumentation Laboratory had made sufficient progress in developing low-drift floated integrating gyros so that Draper and his associates were willing to stick their necks out and attempt an all-inertial bombing-navigation system for the Air Force.

By 1952, MIT had completed its first all-inertial bomb-nav system, known as SPIRE, weighing 2,800 lb. The system was installed on a Boeing B-29 and in 1953 it flew from Boston to Los Angeles automatically guided by its inertial system, carrying Dr. Draper to a classified conference on inertial guidance. When Draper announced the feat during the conference, it created quite a stir. The feasibility of inertial guidance had now been established in actual operation outside the laboratory. In 1956, the Instrumentation Laboratory began tests on a smaller system, called SPIRE Jr., which weighed in at about 1,500 lb.

In 1953, Convair approached MIT to work on the development of an inertial system suitable for the Atlas ballistic missile. Out of this came the basic concepts of the system which eventually went into the Thor.

At the start of the Air Force's all-out ballistic missile program in 1954, there were still such sufficient reservations about the feasibility of inertial guidance that prudence dictated the development of two alternate guidance systems: radio-command and inertial. Originally, each of three original ballistic missiles

had dual guidance systems under development

As the accuracy and reliability of inertial techniques improved, and the size and weight dropped, Air Force has settled on all-inertial guidance for each of its ballistic missiles

Weight of the inertial systems for the Titan and Polaris can not be revealed but a Wright Air Development Center Weapons Guidance Laboratory spokesman recently told AVIATION WEEK that there has been a 10:1 reduction in the size and weight of inertial systems in the past several years (AW April 6, p 55)

Space Guidance

The nature of work under way at the Instrumentation Laboratory has changed somewhat from its early efforts The laboratory continues to explore advanced techniques, such as the so-called "exotic gyros," and guidance techniques required for space probes, such as a Mars reconnaissance vehicle.

On the Polaris program, MIT is a co prime contractor with Lockheed Aircraft Co. The Instrumentation Laboratory is responsible for the complete inertial system design which GE will assemble, and for monitoring and coordinating General Electric's efforts. Draper recognizes that this is an important and necessary mission, but he is not anxious to expand MIT's efforts in this direction.

The Instrumentation Laboratory is organized on a project basis for its Polaris and Titan programs Each project contains the necessary gyro, computer, accelerometer and systems engineers In addition, there are groups of specialists which serve all projects

Although Draper's critics outside the laboratory sometimes accuse him of a lack of tolerance for competing ideas developed by others, project teams in the Instrumentation Laboratory are given considerable freedom in their design approaches

Different Configuration

For example, the stabilized platform for the Titan employs a different configuration from that used for the Polaris missile

The atmosphere here is an interesting combination of that found in an academic research laboratory and that found in an industry development laboratory

Lines of authority and responsibility are moderately flexible There is "none of the maneuvering for position often found in industry," according to one engineer who recently left industry to join the laboratory

For these reasons the laboratory has experienced only a moderate loss of personnel to industry, despite the higher

salaries which the latter usually can offer.

Draper has received an impressive number of awards for his work at the Instrumentation Laboratory, including the Presidential Medal for Merit, the Air Force Exceptional Civilian Service Award and the Navy Distinguished Public Service Award.

Draper likes to describe himself as "only a greasy-thumbed mechanic." This disarming qualification usually is employed just before he launches a devastating attack on an opposing point of view.

Unusual Background

The man who serves as a spark-plug for the laboratory is the product of an unusual academic background. He obtained his first degree in psychology at Stanford in 1922, began working in experimental psychology and soon found himself more interested in the instruments involved than the psychology. He moved on to MIT, obtained a B.S. in electrochemistry, a masters degree without specification (working primarily in aircraft powerplants) and finally a doctor's degree in physics. Draper has been a licensed pilot since 1928.

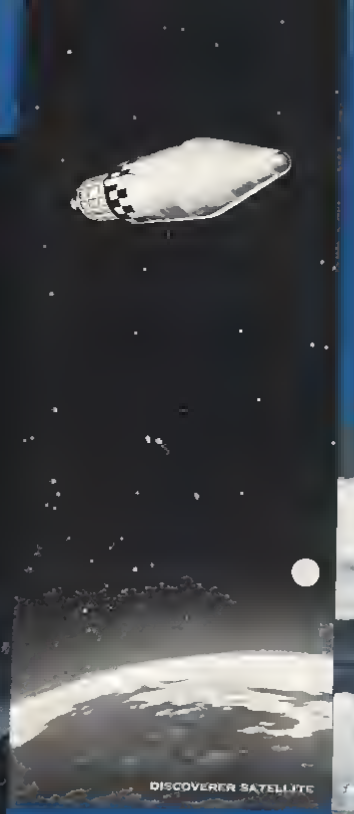
Although the Instrumentation Laboratory is studying exotic gyro concepts, Draper believes that the present floated integrating gyro concept can meet any foreseeable military requirements for missile guidance. And for space vehicle guidance, Draper believes that a combination of inertial and stellar techniques is the answer.

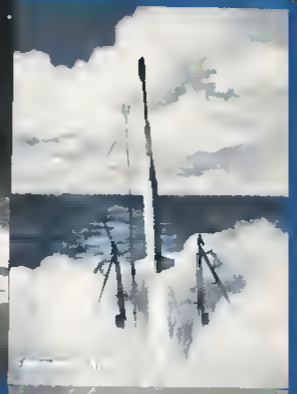
For this reason, the laboratory is devoting the bulk of its development effort to new methods of improving the accuracy and/or reducing the size, weight and cost of present gyro and accelerometer designs.

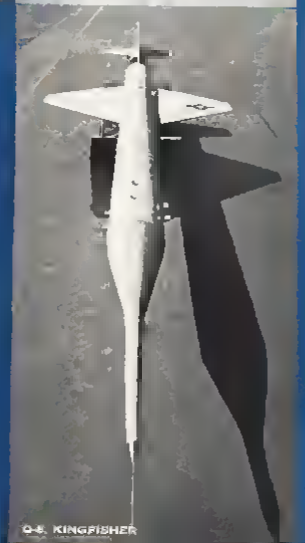
Beryllium Use

For example, it has pioneered in the use of beryllium for gyro construction. The metal has approximately the same rate of thermal expansion as steel, permitting its use in combination with steel where necessary. It has approximately 50% more stiffness than steel, yet weighs only slightly more than magnesium. Beryllium dust can be toxic if inhaled by machine operators, but this problem has been solved through use of vacuum dust catchers mounted in close proximity to the machine work.

With expanding industry activity in inertial guidance, and a fast disappearing need for conventional aircraft/shipboard fire control systems, the nature of the Instrumentation Laboratory's work is likely to change in the next several years. Undoubtedly it will devote an increasing percentage of its efforts to the nation's space programs and already has several projects under way.







EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

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ADVANCED PROJECTS AT LOCKHEED

POLARIS FBM

DISCOVERER SATELLITE; MIDAS; SENTRY

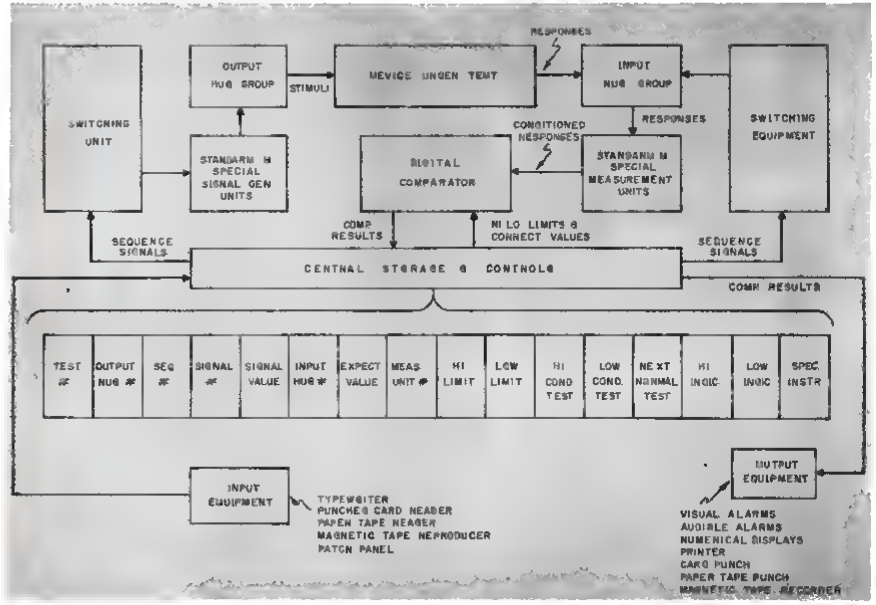
X-17

Q-5, KINGFISHER

X-7

SPACE STATION

Lockheed MISSILES AND SPACE [illegible] IS ON



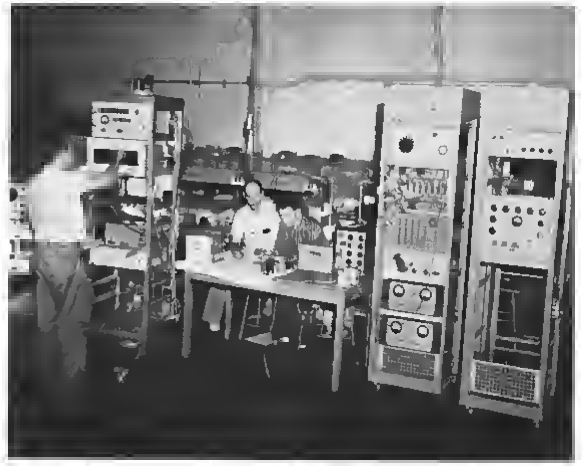
ULTRA HIGH SPEED automatic checkout equipment developed by Epsco for testing complex weapon systems is outlined above.

System Speeds Missile Pre-Flight Check

Cambridge, Mass.—Automatic checkout equipment which can make up to 10,000 test decisions per second, permitting missile pre-flight checkout in a few seconds or a full trouble analysis in minutes is being offered by Epsco, Inc.

The high-speed operation stems from the use of high speed digital computer switching and decision-making techniques. All measurements are converted into digital form, allowing almost any desired degree of accuracy. The ultra-high-speed design also permits precise dynamic performance measurements on servomechanisms and other circuits where usual static measurements don't adequately evaluate circuit performance.

Speed up of the checkout on a weapon/support system should permit a significant gain in operational life by reducing extensive test time, Epsco believes. For instance, at recent Dayton avionics conference, Richard W. Hanford, Missouri Research Laboratories, reported that one interceptor fire control system undergoes total of 700 hr. of testing in the airframe manufacturer's plant before it ever reaches the military user. Once in the field, 5 hr.



EPSCO missile checkout system includes monitoring equipment (left rack), test and calibration equipment in racks at right. Equipment on workbench is precision rms-to-d.c. converter.

Goodyear Aircraft Designs BMEWS Antenna

Ballistic Missile Early Warning System (BMEWS) tracking radar antenna, shown in this artist's conception, employs an 84-ft. diameter antenna designed by Goodyear Aircraft Co. for Radio Corporation of America, BMEWS prime contractor. Antenna will be enclosed in a 140-ft. diameter rigid spherical radome. Prototype model now is being installed at RCA's Moorestown, N. J., facility for engineering tests. Tracking radar is an outgrowth of RCA's extremely accurate AN/FPS-16 monopulse radar, widely used for missile tracking and range instrumentation. Antenna tower is constructed on pylons extending through the building and resting on 55-ft.-wide 8-ft.-thick octagonal slab in the ground to provide extreme rigidity.

of test is required before each flight using conventional manual test equipment, Hanford said. This indicates that a sizable portion of a weapon's useful life now is consumed in checkout.

Epsco currently holds a number of contracts for automatic checkout equipment, not all of it designed for ultra-high-speed operation. The company is producing a high-speed system for General Electric which will monitor an atomic reactor. Other Epsco automatic checkout equipments have been or are being developed for AC Spark Plug's Thor inertial guidance system, for Convair's Terrier and Atlas missiles, and for Douglas Aircraft's Nike Zeus.

Epsco's first effort in this field was an engineering study of a complete rapid automatic checkout system (called RACO) for the Convair F-106. This effort was a natural outgrowth of Epsco's early start in the fields of pulse code modulation telemetry equipment and digital data reducing processing systems. Company also sells certain off-the-shelf items, such as its high-speed analog/digital converters to some of its competitors in the automatic checkout equipment field.

Recently Epsco formed a new subsidiary, known as Monitor Systems, Inc., in the Philadelphia area which will specialize in automatic checkout and monitoring systems. The new operation is headed by Harry H. Rosen, former manager of data processing and computation at General Electric's Missile & Space Vehicle Department.

Flexible Designs

Because automatic checkout equipment usually must be designed concurrently with the weapon/support system it is to test, it must be sufficiently flexible in design to accommodate changes in the weapon/support system even after the latter has gone into field use.

This, Epsco believes, requires a universal type design and the use of taped test programs which can be easily reversed or changed. Most other companies working in this field hold the same view.

Following are the basic elements of such an equipment:

- Test program, which gives sequence of tests to be performed and the allowable tolerance for measured values.
- Signal generators for introducing test

signals and transducers for measuring system under test response.

- **Comparator circuits** for making comparison of desired and measured values
- **Decision making** (conditional transfer) circuits which enable checkout equipment to alter its test program as a result of its previous findings
- **Read-out devices** for visually indicating test results and pinpointing faulty subsystems or subassemblies, together with means for permanently recording these results.
- **Self-checkout provisions**, which enables equipment to frequently test its own performance and to detect internal failure

With the universal design concept, it is possible to build automatic checkout equipment for a variety of different weapon support systems from a few basic standardized building blocks. The degree of sophistication depends upon the intended use. For example, a system intended for mobile field use to determine whether weapon is operational or not, or to isolate fault down to major subsystem, will be considerably less complex than one intended for factory test or overhaul base use.

Operational Features

One important feature in Epsco's new ultra-high speed checkout equipment line, which it calls 'Guardian,' is the ability to make dynamic performance measurements on servo systems, such as radar tracking circuits, automatic flight control and inertial guidance stabilization circuits. With conventional slow-speed testers, a signal corresponding to a given angular displacement is introduced and the system is checked to determine if this signal produces a corresponding angular movement of the radar antenna, the control surface or the stabilized platform.

A servo system can successfully pass such a test, yet fall down seriously in actual operation because of velocity or acceleration tracking errors which cannot be detected by static test.

With Epsco's Guardian, a measured pulse of electrical signal can be introduced and the servomechanism's dynamic response can be measured in terms of the magnitude of its overshoot and its "settling time" to damp out to a prescribed value.

Another feature which can be provided is what Epsco calls an 'urgency selector." This offers the operator two or more alternate test routines depending upon the urgency of the situation.

All measurements of voltage, current, frequency and/or power are converted from their original analog form into a binary (digital) code prior to comparison with desired values, which also are stored on tape program in digital form. If an accuracy of one part in a thousand is desired, a 10-bit code can be used. If greater (or less) accuracy is needed, a longer (or shorter) word length is employed.

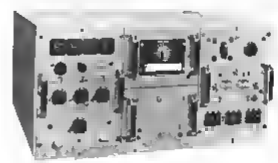
Conversion is accomplished by means of one of Epsco's standard high speed analog-digital converters. The vacuum tube model can make 37,000 analog-to-digital 13-bit word conversions per second, or 44,000 per second for 11-bit words. A newly-developed transistorized converter can produce 25,000 analog-to-digital conversions per second or 100,000 digital-to-analog conversions per second for an 8 bit word length.

Epsco has recently developed a new device for converting complex analog waveforms into equivalent rms value prior to digital conversion with an error of less than 0.01%, according to company president Bernard M. Gordon. This new converter is at least 10 times more accurate than any comparable device now on the market, Gordon says.

Central Checkout Center

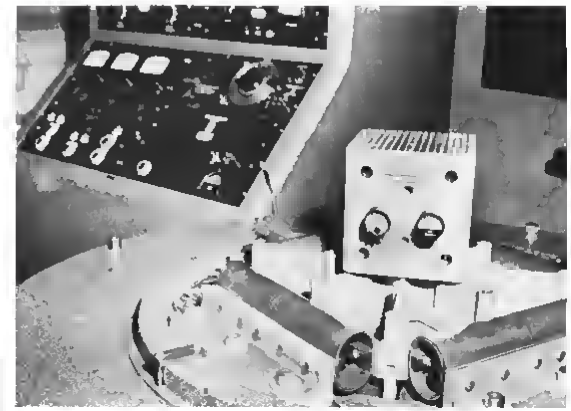
Washington — A single automatic checkout equipment center, located in the central U.S. and connected by landlines or radio circuits to military bases and installations around the country which would enable centralized center to check weapons at remote sites for operational readiness, was proposed here during the recent Military Electronics Convention.

Granville L. King, Packard-Bell Electronics Corp., said that such a center could save considerable money now spent for checkout equipment at each individual military base and installation. A centralized checkout point also would give military aircraft greater mobility because they need not transfer their checkout equipment to new bases. King said that Packard-Bell has conducted studies of such a centralized checkout center and now is doing advanced development aimed at this goal.

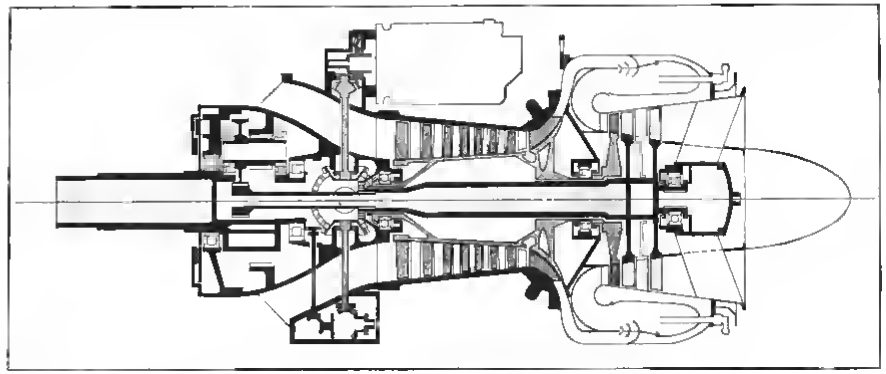


UHF Transmitter

High power airborne UHF transmitter, rated 1 kw, weighs less than 200 lb, measures 30 x 27 x 15 in. Developed by Electronic Communications, Inc., new Model 28 provides 1,750 channels with 20 instantly available preselected channels. Transmitter is entirely self-contained, operates from 360 to 1,200 cps power.



RMC-LINDSAY ONLY GAUGE TO STAND THIS TEST — This photograph shows vibration testing of RMC-Lindsay pressure gauges on the 3200 force pounds Calidyne Vibrator to 50 G output amplitude .010 to 20 Cycling frequencies to 2,000 cps. The test is conducted so as to parallel actual installation conditions, with gauges subjected to 350° F under operating pressures. Complete test reports are available on request.



LYCOMING T55 two-stage power turbine rotation is reverse of compressor-driving turbine obviating need for intermediate stator

Lycoming T55 Cleared for Airframe Use

By Erwin J. Bulban

Stratford, Conn.—Performance exceeding major specification guarantees was demonstrated by the new Lycoming T55 free power turbine during its 50 hr. U. S. Air Force Preliminary Flight Rating Test, thus clearing the turbine for airframe installation.

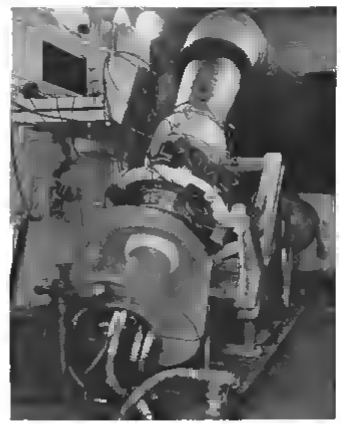
First installation is scheduled for the Vertol YHC-1B Chinook helicopter which is expected to form an important segment of the U. S. Army's future helicopter inventory. First T55 turbines for twin-engine YHC-1B delivery probably will be delivered to Vertol by Lycoming Division of Avco Corp. in late summer of 1960. A 150-hr. test on the T55 probably will be completed by the end of August 1960. FAA will coordinate with Lycoming on test as part of engine's civil certification program.

Minimum guarantees officially established as a result of the 50 hr. trial include these key performance areas:

• **Military power rating** of 1,900 shp (1,985 eshp), compared with Lycoming's guarantee, before the test, of 1,850 shp (1,934 eshp). Engine actually demonstrated output of 2,090 shp (2,190 eshp) during the official test.

• **Fuel consumption** at military power of 0.670 sfc (0.641 esfc) compared with a previous Lycoming guarantee of 0.677 sfc (0.648 esfc). Engine achieved 0.617 sfc (0.593 esfc) during the official test.

Indications are that the minimum guarantee data is on the overly conservative side. This observation is based on comparing the maximum turbine inlet temperature used during Lycoming's tests (1,650F) with the actual temperature specified for the test of 1,600F, which indicates that Department of



ENGINE stops and starts were made at 45 deg. angle on test stand (left), complete power turbine assembly is removed (right)

General Electric moves to provide a more effective

DEFENSE SYSTEMS CAPABILITY

KARSH, OTTAWA

RICHARD L. SHETLER
General Manager
Defense Systems Department

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- **Full back-up resources**

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In line with this requirement, General Electric's Defense Systems Department, headquartered in Syracuse, New York, draws together under one roof, the systems capabilities and long-range planning functions required to draw on all of General Electric to provide the total solution to specific defense problems of the military departments of the Department of Defense and other government agencies.

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The Defense Systems Department is a unique department within General Electric's Defense Electronics Division. Completely systems-oriented, DSD has no need for equipment design or fabrication facilities. While it determines the specifications to be met, the Defense Systems Department assigns design and fabrication functions to other General Electric departments or to some subcontractors among the 45,000 suppliers to General Electric.

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- Competent systems engineering
- Continuous program evaluation
- Efficient specification and procurement

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The Defense Systems Department offers its customers outstanding qualifications for meeting total prime and support system requirements including long-range planning and feasibility studies. For example, it has . . .

Demonstrated systems competence: Recent examples include the highly successful radio-command guidance system for the USAF's ATLAS ICBM which precisely guided the Atlas into orbit around the earth on December 18, as part of Project SCORE.

Full back-up resources: The full range of General Electric's scientific, engineering and manufacturing skills supports DSD capabilities.

For example, the Company's research and development programs, carried on by over 100 laboratories at an annual cost of 300 million dollars, provide the depth of knowledge for vital technological break-throughs.

For more information—or for a copy of brochure GED-3760, describing the Department's defense systems capabilities—write to R. L. Shetler, General Manager, Defense Systems Department, P.O. Box 457, Syracuse, New York. 226-1

Progress Is Our Most Important Product

GENERAL ELECTRIC

Defense and Lycoming are following a policy of taking the new 2,000-shp-class turboprops through a program of gradual "small steps" rather than attempting major strides at this stage of their development.

Further indications of the T55's growth potential are seen in fact that the Chinook version—T55 L-5—a so-called "high-speed" model the Lycoming specification guarantees 1,940 shp (2,025 eshp) military power rating and fuel consumption at military power of 0.656 sfc (0.629 esfc).

In the high-speed model, drive will be taken directly from the engine at 14,500 and feed to right-angle drive developed by Vertol, using the right-angle drive to provide necessary gear reduction at a weight savings over the conventional front-end reduction gearing. This idea also will permit installation of an integral oil tank and cooler system in the space otherwise occupied by reduction gear.

Lycoming believes that the present basic T55 also can be improved to produce 2,400 shp with an optimum power turbine speed of 15,300 rpm and a specific fuel consumption of between 0.59 and 0.625—the variation in fuel consumption depending on the development effort directed towards higher performance. This development could take approximately a year-and-a-half after qualification of the present T55-L-5 and could be achieved at an increase in engine weight of about 15 lb.

Advanced Version

A more advanced version of this powerplant, particularly aimed at further reducing fuel consumption, probably would result in a powerplant of 2,400 shp with 15% lower sfc and a power potential in the magnitude of an additional 15%, Lycoming engineers indicated.

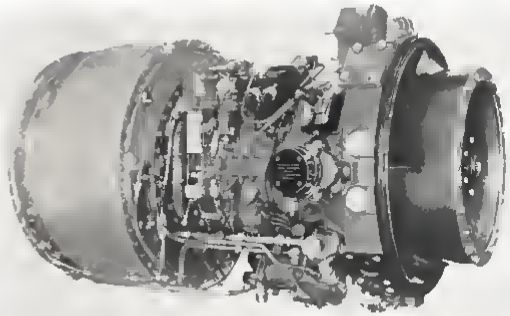
Looking ahead towards turbojet applications of the basic T55 configuration, there are possibilities of overcoming some of the performance losses normally attendant in a straight adaptation by going to the bypass configuration. By removing the gear package in the front end of the engine and extending the power shaft, the T55 could make an economical two-spool multistage bypass turbojet—the bypass ratio dependent upon specific power requirements. The company apparently has been discussing a bypass jet configuration of its T55 with some prospective customers.

Some possibilities for fixed-wing applications of the turboprop T55 configuration include the de Havilland-Canada DHC-4 Caribou, which advanced to the point where test engines and specially designed propellers have been run by Aeroproducts Division of General Motors before budget cuts halted this project; and a later model of

the Fairchild J-27, currently being produced with Rolls Royce Dart engines.

Lycoming's T55 engineering team, heavily sprinkled with German technicians with considerable turbine background is built around Wolfgang Stein and Hans Berkner. Overall direction is under supervision of Franz Anselm, vice president-engineering. Basic philosophy is to begin with simplicity and then refine on it. Result is a so-called "universal" engine.

In the T55 the first application of this concept has been fully applied. All models of the engine—turboprop geared helicopter, high speed front or rear drive helicopter, by-pass jet—are built from the basic power section. By changing the integral front-end reduction gear units the T55 is adaptable to either turboprop or geared helicopter drive. The company emphasizes that such adaptations are possible at the field maintenance level without need of special fixtures or jigs or returning the powerplant to a depot. This capability is considered particularly valuable in cases where several different versions of the engine may be operational at a single base or closely situated stations since many parts of the basic powerplant are interchangeable according to the company. Favorable price structures on the basis of volume production are a consideration.



RIGHT SIDE of the Lycoming T55-L-3 is shown above

Initial model the 1,600 shp T55 L-1 turboprop, began as the winner of a USAF design competition in June, 1954. Air Force then was interested in development of a propeller turbine aimed at replacing the piston Wright R1820 for future medium transports and put some $3 million into development up the time that it gave up this airframe program. U. S. Army shopping around for a similar category engine, took over the development in 1956. Lycoming had made the initial test run of the T55's gas producer section in December 1955. First run of a complete engine was in April 1956.

In 1957 after several 50-hr. Preliminary Flight Rating Tests, indications were that there was considerable refinement remaining. The engine reportedly had proven that its basic mechanical design concept was sound, at the conservative turbine inlet tempera-

ture of 1,550F, the engine had power reserves amounting to more than 100 hp over design value, and performance depreciation during the official military preliminary test was negligible.

Two problems: Specific fuel consumption was up from the original goal as stated in the specification—due primarily to compressor design deficiencies which resulted in mismatched flows between stages and there were no firm application in sight for a powerplant of this power.

Development Charge

So in 1957, Lycoming redirected T55 development to the T55L-3. Its specification called for output of 1,850 shp. At turbine inlet temperature of 1,650F at 6,700 rpm., esfc was to be 0.648.

To overcome the problem of compressor deficiencies, the company realigned its test facilities, transferring portions of the work that had been carried out under severe handicaps at its Williamsport, Pa., plant to the turbine section at Stratford and spending $1.5 million of Lycoming money on a new compressor test facility.

Payoff of this effort was successful completion of the T55L-3's 50-hr military preliminary test, which showed the engine had an esfc approximately 5% under specification guarantees, while producing some 200 hp. above guarantees.

Initial contract was awarded early in 1957; a mockup conference was held in September, 1957, first run was made in December, 1957 and the 50-hr preliminary flight test rating run at 1,900 shp was completed in March, 1959.

The T55 currently has some 3,000 hr total running time.

Engine guarantees cover maximum continuous flight attitudes of 45 deg. nose-up and 50 deg. nose-down.

Design of the T55 basically follows precepts laid down on the company's smaller 860-shp T53 (AW June 9, 1958, p. 46)—ruggedness in the attempt to provide reliability in the field where a minimum of trained personnel and maintenance facilities may be available.

Basic overall dimensions are changed only slightly over what might be expected, considering the more than doubling of power. The T55L-3 is approximately only three inches longer than the T53-L-13 and about one inch more in diameter. This refined packaging included exchanging the first axial stage so that the forward roller bearing at the front of the power shaft is set underneath the first axial stage.

Ball Bearings

Use of a single-point ball bearing support at the rear of the shaft cut bearing distance, permitting the outer exhaust flange to be closer to the combustion chamber, shorter bearing distance on T55 permitted use of a more-constant diameter power shaft (on the T53 the "squeezed-worm" power shaft was bulged in the center portion to bring critical speed above operating speed).

T55 air inlet housing is a one-piece magnesium casting forming an inner housing, an outer air inlet shell and four hollow connecting struts. The inner air inlet funnels air to the compressor and also serves as a mounting base for most of the external engine components and accessories. Connecting struts provide the following functions: three of them act as inducing air ducts to channel hot compressor bleed air into the interior of the inlet housing casting; two struts provide passages through which oil enters and leaves the integral engine oil tank (T55L-5 high-speed version) and three of the struts enclose the shafts delivering power to the engine-mounted accessories and components.

The inlet housing is the engine's main support structure: the four engine mounting pads being located about its periphery. The front face of the casting also is provided with bolt holes to allow mounting the engine cantilever from the face—the installed engine is largely supported cantilever from the inlet housing whether mounting pads or the bolt circle are used.

Gas producer rotor section consists of an eight-stage axial-centrifugal compressor and a compressor-driving turbine. First seven compressor stages are all steel axial, the eighth is a titanium centrifugal. Axial and centrifugal stages are kept aligned by steel spacer rings, this assembly is held together axially over a steel retaining sleeve. By removing either half of the split compressor case, access is provided to that portion of the compressor.

Compressor-driving turbine is a single-stage axial-flow wheel bolted to the aft end of the compressor assembly. Wheel has hollow blades, each fastened by a fir-tree attachment. Hollow blades are used to reduce weight and root stresses; if blade cooling is required at a later stage in the engine development, the cores could be used in this function, Lycoming points out.

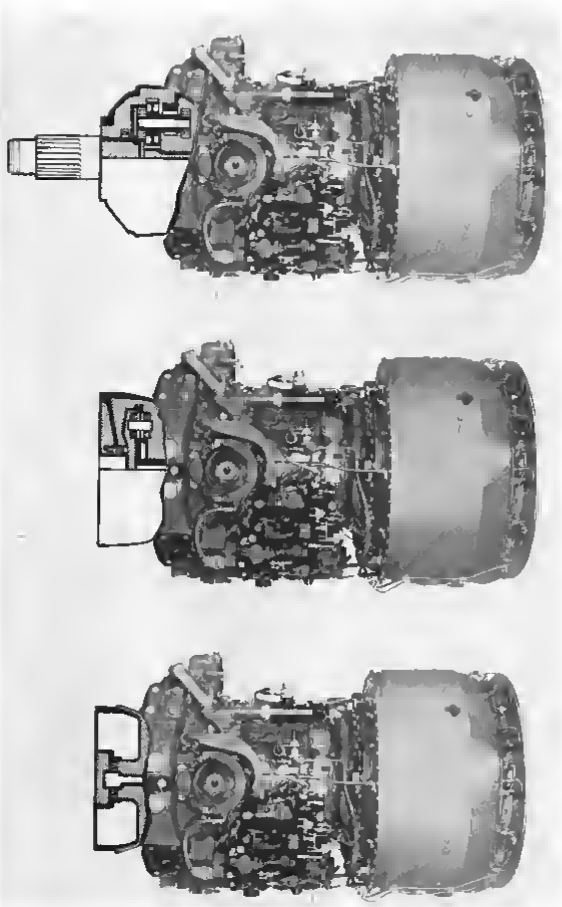
Diffuser Assembly

Compressor diffuser assembly diffuses air leaving the centrifugal compressor stage to produce a final pressure ratio across the complete compressor, approximately 6:1 in the L-5. It also directs compressor discharge air into the combustion chamber. Diffuser housing is a rigid steel structural member that, combined with the combustion chamber housing, aids in maintaining rear-end bearing alignment. Power turbine section has two wheels turning in a contrarotating direction from that of the compressor driving turbine, eliminating the need for an intermediate stator between the power turbines and compressor-driving turbines—a further idea to keep the engine length down. Power transmission shaft is hollow-steel and barrel-shaped with two ball thrust bearings at the aft end and a roller bearing at the front. Power shaft splines to a male output shaft at the front of the engine and is intem-

Lycoming T55 Helicopter Engines

Major Specification Guarantees (Standard Day)

	T55-L-3	T55-L-5
Military Power Rating	1,900 shp 1,565 eshp.	1,948 shp. 2,025 eshp.
Fuel Consumption		
Military Power	0.670 sfc 0.641 esfc	0.656 sfc 0.629 esfc.
Oil Consumption		
Military and Normal Power	0.20 gph	0.20 gph.
Front Drive Output Shaft Speed		
Military Power	6,750 rpm	14,550 rpm.
Maximum Turbine Inlet Temperature	1,650F	1,650F
Maximum Exhaust Gas Temperature	1,100F	1,100F
Engine Dry Weight	600 lb	660 lb.
Maximum Continuous Flight Attitude Conditions	45 deg nose-up 50 deg nose-down	45 deg nose-up 50 deg nose-down
Acceleration from Flight Idle to Military Power	3.5 sec.	3.5 sec.



TURBOPROP, helicopter and high speed adaptations of Lycoming T55 are shown from top

ally splined to couple to a power absorbing unit.

Power turbine and shaft assembly are removable as a unit by removing the bolts that mount the combustion chamber housing to the compressor diffuser housing flange. The operation also exposes the compressor-driving turbine, and can be completed without removing the engine from the airframe.

Exhaust Diffusar

The exhaust diffuser assembly is located aft of the two power turbine wheels. Assembly comprises an inter housing, an outer shell and six hollow connecting struts. Inner bearing housing supports the two aft ball thrust bearings. Lubrication and air to cool the bearings comes into the housing via the hollow struts of the assembly.

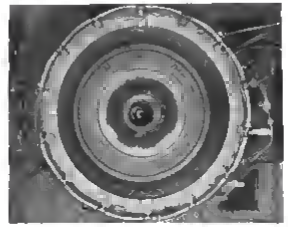
A single flange attaches the entire exhaust diffuser assembly to the rear of the combustion chamber. Power turbine power shaft and exhaust diffuser assemblies can be inspected by unbolting the exhaust diffuser assembly from this flange.

The accessory drive gearbox houses an accessory gear train driven through a bevel gear mounted at the front of the gas producer rotor shaft. The gear train drives a lubrication and scavenge pump, a gas producer speed tachometer generator and the Hamilton Standard engine fuel control unit—including integral fuel pumps. Main oil filter is mounted on this gearbox.

Two interesting features:

• **Mechanical torque measurement** originating from a torquemeter sleeve fitted over the engine output shaft. Any twist of the output shaft, as in power transmission, causes the sleeve assembly to ride up or down a cam surface fitted to the output shaft, forcing the torquemeter's sleeve to ride backwards or forwards along the long axis of the output shaft. This lateral movement is picked up by mechanical linkage, amplifying the signal and translating it into a rotational motion of a small output shaft in the torquemeter drive pad. The output shaft drives the "black box" on the torquemeter drive pad, in turn generating a d.c. electrical signal proportional to the degree of rotation of the torquemeter drive shaft, transmitted to an inverter and the a.c. synchro signal delivered to the torque indicator.

• **Interstage bleed system** to prevent surge at all low levels of compressor operation. System utilizes a pressure sensitive "belly band" or belt surrounding the bleed valve system between the sixth and seventh axial stages. The pressure-sensitive valve operates as a function of compression ratio. Belt snaps open during low pressure levels to permit engine operation close to the surge line, closes automatically when compression ratio is attained. Device is completely inoperative in the flight operating range.



COMBUSTOR can be pulled free from engine when 72 attaching bolts have been removed. Compressor turbine assembly is exposed above.

Dassault Mirage 4 Fighter Attains Speed of Mach 1.9

Paris—Dassault Mirage 4 jet fighter reached a speed of Mach 1.9 on its 14th flight. Aircraft presently is powered by two Snecma Atar 9 turbojet engines. A larger 125,000 lb. gross weight version will be powered by two Pratt & Whitney J75 engines, built under license by Snecma.

The Shape of Flight The shapes of things that fly have always been determined by the materials they are made of. Feathers form wings that are basically alike for all birds—and membrane forms an entirely different wing for insects. It takes thousands of years, but nature improves its materials and shapes, just as technology improves the materials and shapes of aircraft. But here the improvements in materials are so rapid that designs become obsolete almost as soon as they are functional.

Today, the aeronautical designer has types of materials that didn't exist just a few short years ago. Steel is a good example—*five* new types have become available in the past year through USS research: USS Airsteel X-200, an air-hardenable alloy steel with 230,000 psi yield strength; USS Strux, an alloy steel with close to 300,000 psi tensile strength; USS 12 MoV and USS 17-5 MnV Stainless Steels for high speed aircraft and missiles; and USS Stainless "W", a precipitation hardenable stainless steel.

Write for complete technical information about these remarkable new materials. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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USS **United States Steel**

LARGE canopy and lengthened nose differentiate Gnat trainer from standard Mk 1 fighter. Fuselage was lengthened 9 in.

Folland Pushes Gnat as T-38 Competitor

Hamble, Hants, England—Folland Gnat tandem seat jet trainer scheduled to fly later this month, is a forerunner of a proposed supersonic version planned to compete with the Northrop T-38 series (AW July 20, p. 19).

Present Gnat trainer performance is subsonic; the wing thickness ratio is 7%, the Bristol-Siddeley Orpheus Mk. 100 engine is rated at 4,230 lb. static thrust and there is no afterburner.

Folland claims that with a 5% wing and afterburning, the Mk. 2 trainer will have better rate of climb and landing speeds than the T-38-2, but its top speed and endurance will be somewhat under that of the Northrop product.

Company acknowledges that the T-38 is the airplane it has to beat for export orders in the international market. But a look at the time scale for both airplanes indicates that Northrop has a healthy lead and will undoubtedly continue to hold it.

Folland now has an order for 14 pre-production trainers built for the Royal Air Force to evaluate at the request of the Ministry of Supply. The company expects to get a follow-on production order soon and negotiations have been underway for some time (AW Aug. 3, p. 23). Gnat Mk. 1 fighters have not sold at the hoped-for rate; 60 have been ordered in total, but no new contracts have been signed for the little fighter in more than 13 months. The first prototype Gnat flew almost five years ago.

The trainer is basically the Gnat Mk. 1 fighter with a new wing, lengthened fuselage, two seats, new vertical

INCREASED size of vertical tail is apparent in view above. Rotatable fixtures are used (below) in completing assembly and installations in forward fuselage section.

and horizontal tail surfaces and a different engine. In many other respects, says the company, the airplane uses components of the Mk. 1 fighter.

Trainer requirement for tandem seating resulted in a fuselage length increase of about nine inches. This was done by extending the fuselage aft of the pressure bulkhead which formed the back of the fighter cockpit. Fuel tank and equipment bay, which were in this location, have been moved to make room. The fuel is in the intake fairings replacing the twin 30 mm. Aden cannon and ammunition boxes, and the equipment is moved to the nose.

Windshield is curved and a large, single-piece blown canopy covers student pilot and instructor. Company says that about 40% of the few castings used on the Gnat Mk. 1 are used.

New wing has increased area to give improved low-speed handling, and a slightly reduced wing thickness ratio. The fighter version has been flying with an 8° wing and the trainer now has seven. Wing area for the trainer is 175 sq. ft., which is 40 sq. ft. more than on the fighter.

The inboard ailerons of the fighter have been dropped in favor of the more conventional outboard movable surfaces; split flaps are added inboard. Improved lateral control results at low speeds. About 100 gal. of fuel are carried in integral tanks in the wing.

The increased wing area and lengthened fuselage meant increasing the vertical and horizontal surfaces. Longitudinal control remains similar to the fighter: elevator is mechanically locked to the tailplane stabilizer to give a slab surface. If there is a hydraulic failure, the elevators are unlocked and then operate manually. Ailerons are powered, but the rudder is operated manually against feel springs.

Folland Type 4 lightweight ejection seats are fitted. This fully-automatic seat is a development of a design by the Swedish Saab Aircraft Co. Seat ejection velocities will be on the order of 80 fps. Leg restraint gear is used, and other features of the seat include a combined parachute and seat harness and a single connection for oxygen, microphone and earphones.

Total internal fuel is 260 gal., which the company says will give a two-hour endurance. Two drop tanks carrying 66 gal. each can be added and increase endurance to just under three hours.

Future development of the Mk. 2 trainer will have a 5° wing, which will have less area than the trainer wing now used. It would be about 150 to 160 sq. ft., according to chief project engineer R. K. Page, plus full-span leading edge flaps and an advanced lateral control system.

Engine afterburning might be one of two types. Page added either the Swedish development which is used on de Havilland Ghost and Rolls Royce Avons in Sweden, or a Bristol Siddeley design. The latter is probably the basic Bristol Wet-Heat developed some years ago for the Orpheus but so far not used in any service application.

Expected performance for the Mk. 2 trainer will be Mach 1.5 at altitude. Time to climb to 50,000 ft. will be about three and one-half minutes from time of brake release. Page estimates.

Span of the current Mk. 1 trainer version is 24 ft., length is 30 ft. 9 in., and over-all height is 9 ft. 7½ in. Gross weight is 7,500 lb.

Maximum level flight speed for the Mk. 1 trainer is Mach 0.97, ceiling is over 45,000 ft. Takeoff distance, ground run is about 1,500 ft.; landing distance with a drag chute is about 1,740 ft.

CJ-805-3 Attains Mach 1.1 in XF4D

General Electric CJ 805-3 turbojet engine installed in a Navy leased Douglas XF4D has attained Mach 1.1 and 50,000 ft. altitude. Test program included air starts at altitudes to 42,000 ft. During 20 flying days in June the XF4D exceeded 7 hr. of utilization per flying day.

MH-1521 Broussard has a span of 45 ft. 4in and length of 28.2 ft. Wing area is 274 sq. ft. Payload of 1,655 lb. can be hauled 745 mi.

SMALL workhorse is geared to operate into 900 ft. strips, in tropical climates. Agricultural version grosses 5,953 lb.

Aviation Week Pilot Report:

French Broussard Has Good Rough Field

By Robert I. Stanfield

Paris—French-built single engine, all metal, six to eight place MH-1521 Broussard is a high-wing workhorse with twin vertical stabilizers, capable of hauling up to 1,655 lb. of freight 745 mi., and which can operate into the most primitive and small landing fields or strips.

Good flying characteristics and short field capabilities were evidenced during AVIATION WEEK flight evaluation, in which the Broussard—grossing about 4,400 lb.—was maneuvered at 50 kt. (57.5 mph.) indicated, and flown off and onto a grass strip in 400 ft. and 200 ft., respectively.

Airplane, manufactured in Rhenus, France, by Societe des Avions Max Holste, is geared to operate in tropical climates and into the standard Algerian field of about 900 ft. length. Power plant is the Pratt & Whitney 450 hp. R985 engine, which turns an all metal Hamilton Standard 2D30 constant speed propeller.

Cost of the Broussard is 20 million French francs—about $40,000—which includes standard dual controls and instrumentation, and optional VHF, HF, radio compass, panel lighting, navigation-landing lights, cabin heating and sanitary equipment. Total orders—among the highest ever placed with a French aircraft company—have called for 458 aircraft.

Of the total, 385 were earmarked for the French air force (of which 212 have been delivered), 24 to the French army, 3 to the navy, 2 to civil aviation authorities. Civilian orders include the demonstrator, owned by Max Holste, plus 44 deliveries to Algeria, Argentina, Brazil, Cambodia, Gabun, Haute Volta, Madagascar, Morocco, Sahara, Sudan and Tunisia.

Production is at the rate of eight airplanes a month, with current orders running through March, 1962.

Civil-Military Versions

In addition to its light cargo capabilities, the MH-1521 is commercially applicable as a six to eight place transport in executive airplane, and as a duster-sprayer. Militarily, the French have used the airplane extensively during brush fire warfare for field liaison, medical evacuation, photo reconnaissance, transport and as a flying command post.

Sitting on the ground, the Broussard presents a solid, rugged appearance. Its orthodox structure was designed to provide quick and economical repairs, overhauls and inspections. All structural parts are removable and interchangeable, seats can be dismantled at about one minute per unit, leaving a clear cabin floor; wide jettisonable door—3.78 by 4.2 ft.—can be easily dismantled, for expeditious loading of cargo or stretchers.

The MH-1521 is constructed of ribs and stringers with dural sheet skin riveted. Fuselage has a rectangular section at cabin level, while the floor is ovoid. Two main couples of box structure support the wings. Landing gear and bracing masts attach to the main front couple.

Each half of the spring steel gear is connected to the fuselage by two attachment parts, one rigid, the other guided for blade strain. The tail wheel is steerable and self centering.

The rear section is constructed of two reinforced couples on which the tail plane, tail wheel and tail cone are fixed. Latter is screw assembled and can be quickly dismantled for maintenance of elevator control and gear. The two fins and tail plane are all metal. Elevators and rudders are fabric covered on a metal structure.

Engine cowling consists of three removable panels attached on a frame fixed on the engine mounting. Lateral panels are fixed with Dzus fasteners and held in open position by rods, facilitating dismantling. Light alloy wing fuel tanks supported by three bridges, are welded. The oil tank is stainless steel. Ducts are fireproof.

The wing center section includes a front and a rear spar connected by ribs. The forepart is made of two duralumin sheets (of constant thickness, decreasing height) riveted on a duralumin core. Rear spar is made of folded duralumin plate. The upper skin is riveted and the lower screwed on the frame.

The leading edge is divided spanwise into three boxes for easy maintenance and interchangability. Assembly to the wing center section is via screws, readily removable for inspection. Wing masts are steel tube, with fairing. Slotted flaps and ailerons are of fabric-covered metal structure, attached to rear spar by cast magnesium struts. Removable wing tip is made of two welded half shells.

Aircraft's Instrumentation

Demonstrator flown by AVIATION WEEK pilot was the six-place company-owned F-BICX. Aboard were Pierre Clostermann, chief pilot for Max Holste, and two passengers. Gross weight of the Broussard was about 4,400 lb. As an alternative to the six single seats, customer may order two forward seats and a pair of three-seater "banquettes" for transportation of eight passengers.

Engine controls, grouped in two separate sets on both the left and right side of cockpit include levers for manifold pressure, prop control and mixture. Dual stick-type flight controls also are standard equipment. Main folding instrument panel carries flight instruments on the left, engine instruments centered and radio controls and circuit breakers on the right side of the panel.

Standard engine instruments include tachometer, oil temperature and pressure gages, boost pressure, fuel pressure and chronograph. Flight instruments include artificial horizon, directional gyro, turn and bank, rate of climb, air speed, altimeter, magnetic compass and vacuum feed. Electric control panel includes voltmeter, set of circuit breakers, engine fire extinguisher, battery and generator switches.

Elevator and rudder trim knobs set on small center pedestal, directly below main panel. Aileron, rudder and elevator controls on the MH-1521 are composite (tubes and cables). Rudder is operated by pedals hinged under the floor.

Engine fired up quickly and the Broussard was taxied to takeoff position. Nose sits a bit on the high side, and aircraft was S'd slightly during taxi run for visibility purposes. Large windshield is made from two symmetrical plastic glass sheets, assembled on frame by means of screws and rubber interposition.

Field elevation at Le Bourget is 180

Capabilities

BROUSSARD seats can be dismantled within one minute per unit, leaving a clear cabin floor for cargo or stretchers. Door measurement is 3.78 ft. x 4.2 ft.

MH-1521 Broussard

Specifications

Span	45 ft
Wing area	274 sq ft
Aspect ratio	7.5
Length	28.2 ft.
Cabin dimensions:	
Length	10.15 ft
Maximum width	4.1 ft
Mean height	4.3 ft.
Door size	3.78 ft x 4.2 ft
Empty weight (one seat)	3,373 lb
Gross weight	5,511 lb
Maximum authorized weight	5,953 lb.
Wing loading	20.15 lb./sq. ft.
Power loading	4.94 bhp
Fuel capacity	661 lb (110 gal.)
Payload (pilot and max. range)	1,655 lb

Performance:

Takeoff:	
Ground run	607 ft.
Distance to clear 50 ft	1,066 ft.
Landings:	
Ground run	328 ft.
Distance after clearing 50 ft	787 ft
Rate of climb	1,082 fpm
Level speeds	
Max. continuous (2,300 rpm.)	168 mph (146 kt.)
Max. cruise (2,000 rpm.)	152 mph (132 kt.)
Economical cruise (1,800 rpm.)	136 mph (121 kts)
Minimum speed	62 mph. (54 kt.)
Range (no wind)	745 mi.
Service ceiling	18,045 ft.

ft. Takeoff was made to the northeast, into a 14-kt. wind. Outside air temperature was 27C. Sea level pressure was 1,018 mb. Sixteen degrees of flaps were dropped.

Full throttle was applied, generating 2,800 rpm., and the tail was off the ground shortly after airplane started to roll. Within 400 ft. we were airborne, climbing slightly nose high 1,000 fpm., airplane indicating 60 kt. (69 mph.).

Nose was lowered slightly, and at 2,000 ft. airplane was ascending at 800 fpm., airspeed indicating 70 kt. (81 mph.). Visibility to the rear was no problem in level flight, but during moderate banks the high wing posed an obstruction. Feel of the airplane was good; response to small control pressures was immediate and positive.

At 4,000 ft., pulling 1,800 rpm. outside air temperature 20C, the Broussard indicated 100 kt., for a true airspeed of 109 kt. or 126 mph. At 5,500 ft., pulling 1,900 rpm., airplane held 100 kt. indicated for a true reading of 112 kt. or 129 mph. At maximum cruise—2,000 rpm.—the MH-1521 trues out at 152 mph.

Stability of the Broussard was evidenced during hands-off flight in tight turns. Snapping the stick forward, during level flight, would result in one

long oscillation before nose returned to neutral position.

Airplane has good safe-flight characteristics and is quite docile in stalls power off and on, with and without flaps. With power on, prop turning 1,900 rpm, nose was pulled high until stick was all the way back. Airspeed held to 50 kt. (57.5 mph.), and the MH-1521 continued to fly along nose high, a bit on the sluggish side, but with no fall away or wing dropping.

The Broussard was then leveled off and full throttle applied. Pilots usually hold full throttle to get 115 kt. indicated, then throttle back to required power setting while airspeed builds constant. Retarding throttle but holding just a bit of power, 50 deg. of flaps were dropped. Airplane again was flown nose high at 50 kt. stalled at about 45 kt. indicated (53 mph. true airspeed). Stall was quite docile. Nose would drop and as speed built up airplane would porpoise up then down again. In this manner airplane gently descended.

A small grass strip on the outskirts of Paris was used to demonstrate the short-field capabilities of the Broussard during landing and takeoff. The MH-1521 was pulled off with 16 deg. of flaps, within 500 ft. and was dropped in and stopped in about 200 ft.

Airplane is normally flown into pattern at initial speed of 80 kt. (92 mph.), with about 20 deg. of flaps lowered. On base (or during circular pattern) 30 deg. of flaps were lowered, and speed reduced to 75 kt. Final approach was flown at 70 kt., full flaps. The Broussard was brought over the fence about 60 kt. for a three-point landing, easily coming to a full stop after a short roll.

Both brakes and flaps are hydraulically operated. The FAA approved R985 overhauled engine is supplied with generator, starter, vacuum pump and fuel pump. The 24 v. battery sits in a compartment located aft of the cabin accessible through right side of aircraft.

Airplane has two jack points located forward under the fuselage. A third is at the rear, adjacent to the tail wheel. Crane handling is via two fuselage rings at wing attachment level.

Agricultural version of the Broussard has an empty weight of 3,373 lb., maximum gross weight of 5,953 lb. Mrs. Hulste estimates that an hour's fuel would weigh 176.5 lb., oil, 44 lb., pilot 165.5 lb. and special equipment 194 lb. Available would be 2,000 lb. for payload.

Best speed of the sprayer duster is specified at 81 mph. Capacity of the agricultural tank is 176 gal. and output is 11.6 gal. per min. Spread width is designated as 75 ft. Surface covered during the operation, 185 acres. Density of the spreading 1.1 gal./acre.

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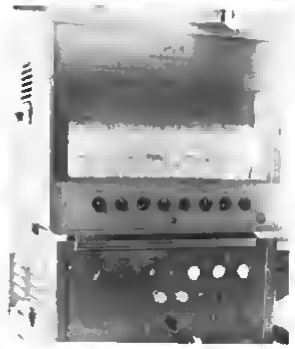
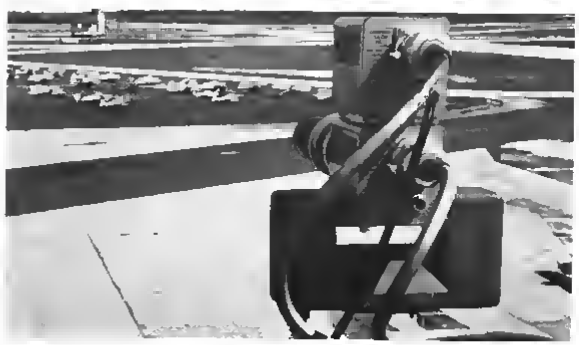


Scanoscope wide screen 7 x 3 in. aspect screen in control tower at National Aviation Experimental Center, Atlantic City, N. J., is being used by Federal Aviation Agency in facilitating surveillance of runways and taxiways during airport traffic analysis programs being studied here by the agency. Control unit at bottom of monitor permits operator to work the 360-deg. pan and tilt head on which the two cameras are mounted some 60 ft. above the airport ramp. He can also switch from a 70-deg. wide angle lens unit to a 100 mm. telephoto lens depending on whether he wants a general view of area or closeup. Monitor was developed by Grimson Color, Inc., N. Y. C.



AMC Contracts

Wright-Patterson AFB—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command

Nonain Division, Northrop Corp., facilities for assembly and testing of T-38 aircraft (PR 11-9-P-9156) $66,175

Utah Division, Thiokol Chemical Corp., Brigham City, Utah: 88 ea. M-16E-1 rocket engines (for Mace missile program) Aerno 36-1606 (PRs EP-9-59B-4400 and amendment No. 1 and EP-9-29B 47991) $736,804

Vertol Aircraft Corp., Morton, Pa.: YHC-1B mockup spare parts development and data (PR 08827) $8 million

National Airlines, Inc., Miami, Fla.: group A modification of contractor-owned L-1049H (Lockheed) aircraft to CRAF configuration (PR FM-9-S-6376) $22,041

Research Inc., Hopkins, Minn.: runway overrun barrier webbing adaptor test, (PR EM-9-9RD-6258), $48,167

Lycoming Division, Avco Manufacturing Corp., Stratford, Conn.: field maintenance and overhaul support of YT53-L-1 engines for H-43B pre-acceptance flight test (PR DP 9-810 4417) $208,755

Bell and Howell Co., Chicago, Ill.: 72 ea. photographic accessory kit (LF-1) spare parts and data for ground support equipment (MIPR R62-09017 SC-01-23) IFB 33-600-59-171 $64,043

Emerson Radio and Phonograph Corp., Jersey City, N. J.: transformer program (PR 08803) $70,059

Special Projects Department, Monsanto Chemical Co., Boston, Mass.: hydrocarbon fuels (two litres each of fifth) to be used for valuation purposes in small laboratory equipment to determine the suitability for use as advanced jet fuels (PR EM-9-RD-6202) $207,000

Olympic Radio and Television Division, The Siegler Corp., Long Island City, N. Y.: 1,785 ea. amplifiers, synchro signal compass, 400 cycle, type MR-1A, Aerno 48-3861, aircraft number F-84F modification program (PRs MO-9 MAINT-27778, MO-6-MAINT-34742, MO-6-MAINT-641 and SM-9-05A-2528-1) $661,738

The Dow Chemical Co., Midland, Mich.: 3,600 lb. of lubricant Bis(phenoxyphenyl)-ether (PR EM-9-RD-6347) $47,250

Dow Corning Corp., Midland, Mich.: 2,000 lb. of lubricant Bis(phenoxyphenoxy)-benzene (PR EM-9-RD-6324) $42,100

Topp Industries Inc., U. S. Science Corp., Los Angeles, Calif.: 2 ea. test sets, central air data computer output engineering data and progress reports. (PR FA-9-RD-4021) $58,410

Shipman, Inc., Falls Church, Va.: 11 ea. spectrograph analyzers (PRs 911105-A 513217-A and amend. No. 1) $100,000

Amoco Chemical Corp., Chicago, Ill.: 10-115 ea. cantridges, starter aircraft engine type MXU-6/A for use on F-105 aircraft (PR 09-6-3725-37871) $89,156

Grayson Corp., Dayton, Ohio: 2,400 ea. launchers rocket airborne training type MA2A in accord with specification Mil-L-25107B (USAF) dated Mar. 24, 1958 and USAF drawing 57K22241 (for training purposes in launching of rockets). IFB 33-600-59-146 (PRs WR-9 FSC10-2014 and amendment No. 1 and WR-9-FSC10-3032) $42,900.

Cook Electric Co., Chicago, Ill.: 722 ea. controls, inverter changeover, type A-2 contractor's P/N 666-154 tuned on miscellaneous aircraft) IFB 33-600-59-180 (PR SA-9-03C2-9218 and amendment No. 1), $29,844

Flight Propulsion Division, General Electric Co., Cincinnati, Ohio: 36 ea. J79-GE-3 turbojet aircraft engines, data and bill of materials for Navy (MIPR R56-1643-45-NOas partial) $4,003,000

Red Bank Division, Bendix Aviation, Eatontown, N. J.: 107 ea. generators, 60 v.d.c. 200 amp. type MA-1 Aerno 42-2028 engineering and maintenance data for C-2C and H-37A aircraft, (PR EA-9 03C-4096) $72,816.

Sylvania Electronic Systems, Waltham Laboratories, Sylvania Electric Products, Inc., Waltham, Mass.: trainer attachments (ECM) to the AN/GPS-T2 radar target simulator trainers, spare parts, ground support equipment, data and installation services. (PRs PE-9-69-4170 and PE-9 6810-4180) $485,463

Pioneer-Central Division, Bendix Aviation Corp., Davenport, Iowa: 41 ea. develop and fabricate individual survival and emergency oxygen kit assemblies. Spec. MIL S 26681 (USAF) and data (PR DO-9 61A-72#11 $98,999

North American Aviation, Inc., Los Angeles, Calif.: 60 ea. rack assemblies 1056-187-63026-31, 179 ea. rack assemblies 1095-63023-37, 45 ea. rack assemblies 1,200 lb. external stores, 100 ea., bomb rack packages 1065-187-63002-40 applicable to F-86 aircraft (PR's WR-9 FSC10-2012 and amendments 1 and 2; WR-9 FSC10-2004 and amendment No. 1). $427,853

Ampex Corp., Redwood City, Calif.: 1 ea., Ampex FR-100 recorder/reproducer and related equipment (PR 916271-A). $55,343

Fabrication Development Division, American Society for Metals, Cleveland, Ohio: machinability of high strength steel program (PR PB-9 MMP 9016) $105,396

Direct Current Motor & Generator Department, General Electric Co., Erie, Pa.: 64 ea. 5001-8125-928-6264 amplidynes, 137 ea. 5203-6105-04-2909 motors (replacement spare components for AD, MD4, MD1A and MD4 fire control systems B-47 and B-66 aircraft) (PRs WR-9-11E-064 and WR-9-11E-967) $37,300

Semiconductor & Materials Division, Radio Corp. of America, Somerville, N. J.: transistor program (production refinement and pilot line production of low power VHF silicon NPIN intrinsic structure transistor) (PR EM-6-MMP-8088) $321,558

Sundstrand Aviation Division, Sundstrand Machine Tool Co., Rockford, Ill.: 150 ea. shafts, interconnecting, 40 Kva., 67 hp., Aerno 48-6575, 156 ea. transmission and governor assemblies, Aerno 48-6976, 150 ea. flanges mounting, input Aerno 48-6782, 158 ea. frequency and load controllers Aerno 48-6991, 156 ea. transformers current, 40 kva., Aerno 48-6338 and spare parts for support of B-52G aircraft (PRs EA-9-02C-4546 and EA-9-631-4562 and amendment No. 1) $693,958

Systems Research Laboratories, Inc., Dayton, Ohio: 15 ea. data reduction consoles (spec. AFCIN-4C 352101-2 dated Jan. 15, 1959 designated as exhibit "A") (PR 61329-6 A and amendment No. 1) $480,000

Radiation Manufacturing Corp., Mount Prospect, Ill.: 1,562 ea., SNR screens projection BM-10 portable spring roller mounted, spec. CG S 172a dated April 21, 1958, type IV, and drawings (PR 33-600-59-136 (MIPR R59-22234-SC-24 and amendment No. 1) $85,228

Westinghouse Electric Corp., Dayton, Ohio: 179 ea. panel controls, generator, 26 v.d.c. type 3B, Aerno 42-736 engineering and maintenance data. IFB AF-33 (600-59-164 (PR SA-9-03C-9240). $58,802

Selwyn Engineering, Inc., Los Angeles, Calif.: barometers, absolute pressure, standards in a/w exhibit WCLCI-2-16 dated Sept. 10, 1958 for service test. (PR IME-9-ST-4455). $99,140

General Electric Co., Erie, Pa.: 4 ea. generators, aircraft, 30 v.d.c. 300 amp. "VQAD," GE P/N 2CM7501, including clamps, adapters and data, product improvement program) for B-58, B-58 C-84, C-97, C-119, C-123, C-124 and C-121 aircraft (PR EA 9-03C-4503) $55,490

Propeller Division, Curtiss-Wright Corp., Caldwell, N. J.: 111 ea. blade taking and heating element assemblies, de-icing (spares for C-124C aircraft) (PR R-9-1010-4322) $575,556

Beason-Lehman Corp., Los Angeles, Calif.: 4 ea. film readers, OSCAR model E (GS1026E); 4 ea., OSCAR projectors (GS 1095); 4 ea. decimal converters model F (GS 1320D); associated data and equipment (PR 813226-A and amendment No. 1). $68,295

Aeropropulsion Operations of Allison Division, General Motors Corp., Dayton, Ohio: design, development and fabrication of a controllable pitch propeller compatible with the Allison T61 turboprop engine, (PR EA-9-03A-4546) $1 million

Checking Einstein with

Purity Plus—*Hughes Products Division engineer checks semiconductor materials to insure purity.*

Exit cones *capable of withstanding temperatures of 6000° F, represent one example of advanced engineering being performed by the Hughes Plastics Laboratory.*

an atomic clock in orbit

To test Einstein's general theory of relativity, scientists at the Hughes research laboratories are developing a thirty pound atomic maser clock *(see photo at left)* under contract to the National Aeronautics and Space Administration. Orbiting in a satellite, a maser clock would be compared with another on the ground to check Einstein's proposition that time flows faster as gravitational pull decreases.

Working from the new research center in Malibu, California, Hughes engineers will develop a MASER (Microwave Amplification through Stimulated Emission of Radiation) clock so accurate that it will neither gain nor lose a single second in 1000 years. This clock, one of three types contracted for by NASA, will measure time directly from the vibrations of the atoms in ammonia molecules.

Before launching, an atomic clock will be synchronized with another on the ground. Each clock would generate a highly stable current with a frequency of billions of cycles per second. Electronic circuitry would reduce the rapid oscillations to a slower rate in order to make precise laboratory measurements. The time "ticks" from the orbiting clock would then be transmitted by radio to compare with the time of the clock on earth. By measuring the difference, scientists will be able to check Einstein's theories.

In other engineering activities at Hughes, research and development work is being performed on such projects as advanced airborne systems, advanced data handling and display systems, global and spatial communications systems, nuclear electronics, advanced radar systems, infrared devices, ballistic missile systems...just to name a few.

The variety and advanced nature of the projects at Hughes provides an ideal environment for the engineer or scientist who wishes to increase his professional stature.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas

Communications	Environmental Engineering
Thin Films	Logical Design
Electron Tubes	Radar Circuit Design
Field Engineering	Material & Component Eng
Semiconductors	Systems Analysis
Test Equipment Eng	Nuclear Electronics

Write in confidence to Mr. Don Ekner, Hughes General Offices Bldg. 6 A8, Culver City, Calif.

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HUGHES AIRCRAFT COMPANY

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Reflective Runway Markings

Reflective aggregate available in white or yellow is designed to make runway and taxi strips more readily visible at night. Aircraft landing lights will make unlighted runway markings visible from two miles out at an altitude of 500 ft.

The aggregate, tested at Air Force and Navy facilities, is bonded at 60F temperatures to dry concrete or asphalt treated with a binder. Compound, used with a conventional pavement striping machine, is applied at a rate of 4 lb per gallon of recommended binder, each gallon covering 80 sq. ft.

Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul, Minn.

Time Delay Relay

Transistorized time delay relay is intended for remote control operations in missiles and satellites, such as closing destruct circuits and deploying drag chutes.

Relays, available in Models 9349 and 9350, meet military specification MIL-R-6106C. Both the 9349 (time delay on pickup) and the 9350 (time delay on dropout) operate crystal can relays inside the package through a transistorized network which determines the time delay. Specifications include ambient temperature range from −55 to +120C, minimal time delay from 0.1 sec to 3 min., operating voltage range 18 to 30 v.d.c., maximum weight 0.35 lb., maximum size 1.531 in. square by 1.812 in. high.

Leach Corp., Relay Division, Los Angeles, Calif.

Missile Solenoid

Solenoid, designed to operate in high temperature areas of missiles and aircraft, can operate continuously in temperatures of 1,000F.

Stroke of the unit is from .010 in. to .060 in. At .010 in. stroke the solenoid will operate a minimum force of 15 lb. Required power source is from 18 to 30 v.d.c., coil resistance at 1,000F is 35 ohms. Diameter is 1¾ in. and weight is 1.3 lb.

Rocker Solenoid Co., 140 N. Marine Ave., Wilmington, Calif.

X-15 Nose Wheel Equipped With Fabric-Tread Tires

Fabric tread tires designed for the nose wheel of the X-15 are compared following landing of the North American research aircraft. Developed by the B. F. Goodrich Co., the tire incorporates multiple plies of nylon cord in the tread to better bind tread and carcass and prevent the tire from throwing its tread during the aircraft's high speed landings.

Hot Gas Motorpump

Hot gas motorpump or auxiliary hydraulic power on missiles utilizes either solid propellant generators or gas bled from the main propulsion system.

The motor, a modified axial piston-type hydraulic motor, provides auxiliary power throughout a range of 0.5 hp at 1,500 psi. to 66 hp at 3,000 psi. Speed ratings for the integral units range from 18,200 rpm. for the 0.095 cu. in./rev. size to 6,500 rpm. for the 2.35 cu. in./rev. size. Motors have been tested at temperatures to 5,000F. Motors, running on solid propellants at temperatures of 2,300F, average one minute endurance.

Vickers, Inc., Detroit 32, Mich.

Solid State Inverter

Solid state power inverter is used to energize either or both General Electric J85 turbojet engines on the Northrop T-38 jet trainer. Inverter replaced vibrator type equipment.

Power inverter, Model No. SIS W41251, for ground or inflight starting

converts 18-24 v d c., to 100-145 v., square wave, 320-360 cps a c power. Output and voltage frequency are proportional to input voltage. Rated load of the inverter is 125 volt amp. with a 3 amp surge. Weight is 3½ lb and the inverter measures 5 x 5 x 3½ in. Unit meets MIL-E-5400 and MIL-E 5272A.

Magnetic Amplifiers, Inc., New York 55, N Y

Petroleum Contracts

Washington—Following is a list of unclassified contracts for $25,000 and over as released by the Military Petroleum Supply Agency:

The American Oil Co., New York: Avgas 91/98, (IFB 59-108) 10,502,000 gal., $1,264,109.

The California Oil Co., Perth Amboy, N J.: Avgas 115/145, (IFB 59-108) 7,350,000 gal., $1,156,800.

O F Collinge Co., Los Angeles: Avgas, 115/145, (IFB 58-108) 8,087,000 gal., $1,417,889.

Cities Service Oil Co., New York: Avgas 115/145 (IFB 59-108) 12,247,000 gal., $12,438,870.

Continental Oil Co., Houston, Tex.: Avgas 115/145 (IFB 59-108) 7,220,000 gal., and Avgas 100/130 (IFB 59-108) 880,000 gal., $1,163,251.

H N Sunray Oil Co., Tulsa, Okla.: Avgas, 100/130 (IFB 59-108) 5,464,000 gal. and Avgas 115/145 (IFB 59-108) 59,112,000 gal., $4,483,918.

Esso Standard Oil Co., New York: Avgas, 115/145, 66,782,000 gal., Avgas 100/130 5,970,000 gal., Avgas 91/96, 717,000 gal., Avgas, 80/87, 377,000 gal., (IFB 59-108) $10,823,102.

General Petroleum Corp., Los Angeles: Avgas 115/145, 4,200,000 gal., Avgas 100/130 1,782,000 gal., (IFB 59-108) $1,941,965.

Tuli Oil Corp., Pittsburgh, Pa.: Avgas 100/130, 2,000,000 gal., Avgas 91/96, 604,000 gal., (IFB 59-108) $875,800.

Humble Oil & Refining Co., Houston, Tex.: Avgas 115/145, 29,250,000 gal., Avgas 100/130 7,830,000 gal., Avgas 80/87, 1,022,000 gal., (IFB 59-108) $3,740,016.

Magnolia Petroleum Co., Dallas, Tex.: Avgas 115/145, 12,000 gal., Avgas 100/130 3,660,000 gal., Avgas 91/96, 750,000 gal., Avgas 80/87, 158,000 gal., (IFB 59-108) $860,886.

Phillips Petroleum Co., Bartlesville, Okla.: Avgas 115/145, 2,850,000, Avgas 100/130 3,891,000 gal., Avgas 91/96, 192,000 gal., Avgas 80/87, 319,000 gal., (IFB 59-108) $1,105,149.

Richfield Oil Corp., Los Angeles: Avgas 115/145, 67,931,000 gal., (IFB 59-108) $11,448,581.

Shamrock Oil & Gas Corp., Amarillo, Tex.: Avgas 115/145, 4,100,000 gal., Avgas 100/130 2,435,000 gal., Avgas 91/96, 345,000 gal., (IFB 59-108) $1,201,005.

Shell Oil Co., New York: Avgas 115/145 21,541,000 gal., Avgas 100/130 10,349,000 gal., Avgas 91/96, 3,072,000 gal., Avgas 80/87 215,000 gal., (IFB 59-108) $8,033,899.

Sinclair Refining Co., New York: Avgas 115/145, 31,371,000 gal., (IFB 59-108) $4,320,302.

Socony Mobil Oil Co., New York: Avgas 115/145, 735,000 gal., Avgas 91/96, 1,482,000 gal., (IFB 59-108) $345,080.

Western Operations Inc., Standard Oil Company of California, San Francisco, Calif.: Avgas 115/145, 4,060,000 gal., Avgas 100/130 2,050,000 gal., Avgas 91/96, 3,440,000 gal., (IFB 59-108) $3,083,510.

Standard Oil Co. (Indiana), Chicago: Avgas 115/145, 2,270,000 gal., Avgas 100/130 3,810,000 gal., (IFB 59-108) $911,457.

Standard Oil Co. (Kentucky), Louisville, Ky.: Avgas 115/145, 780,000 gal., Avgas 100/130, 2,060,000 gal., Avgas 91/96, 1,470,000 gal., Avgas 80/87, 2,740,054 gal., (IFB 59-108) $1,125,343.

The Standard Oil Co. (Ohio), Cleveland, Ohio: Avgas 100/130, 3,120,000 gal., Avgas

82/98 4,664,000 gal., Avgas 80/87, 8,000 gal., (IFB 59-108) $558,998.

Tidewater Oil Co., Los Angeles, Calif., Avgas 115/145, 15,500,000 gal., Avgas 100/130, 5,655,000 gal., (IFB 59-108), $3,375,735.

Utah Oil Refining Co., Salt Lake City, Utah., Avgas 115/145, 1,670,000 gal., Avgas 100/130, 3,260,000 gal., Avgas, 91/98, 10,000 gal., (IFB 59-108), $853,809.

Asiatic Petroleum Corp., New York, Avgas 115/145, 10,500,000 gal., (IFB 59-108), $1,569,750.

Eastern States Petroleum & Chemical Corp., Houston, Tex., Avgas 115/145, 44,100,000 gal., (IFB 59-108), $6,382,236.

Republic Oil Refining Co., Division of Pennzoil Oil Co., Pittsburgh, Pa., Avgas 115/145, 18,900,000 gal., (IFB 59-108), $2,829,330.

Sky Harbor Air Service, Cheyenne, Wyo., Avgas 115/145, 50,000 gal., Avgas 100/130, 335,000 gal., Jet fuel, 4,200,000 gal., Lube oil 1100, 7,000 gal., Lube oil 1010, 20 gal., (IFB 59-117), $129,121.

Standard Oil Co. (Kentucky), Louisville, Ky., Avgas 100/130, 90,000 gal., Avgas 91/98, 90,000 gal., Lube oil 1100, 300 gal., (IFB 59-117), $58,458.

Shell Oil Co., New York, Avgas 115/145, 1,155,000 gal., Avgas 100/130, 2,975,000 gal., Avgas 91/98, 440,000 gal., Avgas 80/87, 4,000 gal., Jet fuel 4, 400,000 gal., Lube oil 1010, 15 gal., Lube oil 1100, 55,000 gal., (IFB 59-117), $1,117,388.

Esso Standard Oil Co., New York, Avgas 115/145, 80,000 gal., Avgas 100/130, 330,000 gal., Avgas 91/98, 50,000 gal., Avgas 80/87, 1,000 gal., Jet fuel 4, 30,000,000 gal., (IFB 59-117), $971,502.

The Texas Co., New York, Avgas 115/145, 60,000 gal., Avgas 100/130, 380,000 gal., Jet fuel 4, 1,800,000 gal., Lube oil 1100, 2,000 gal., Lube oil 1010, 20 gal., (IFB 59-117), $350,095.

Navy Contracts

Following is a list of unclassified contracts for $25,000 and over as released by U. S. Navy contracting offices.

DEPARTMENT OF THE NAVY, BUREAU OF AERONAUTICS, Washington 25, D. C.

Chance Vought Aircraft Co., Dallas, Tex., research and development of integrated flight capsule design for F8U-1 aircraft, NOas 59-6150-c(AF-52-4744-s8), $1,055,761.

Texas Instruments, Inc., Dallas, Tex., AN/APS-86 radar sets and components, in accordance with Spec. MIL-R-21113(Aer) with exceptions thereto dated Oct. 15, 1958, letter contract NOas 59-6252(FD-31-1527-59) and Revision A thereto), $9,373,778.

Goodyear Aircraft Corp., Akron, Ohio, conduct a study of terrain radar return, NOas 59-6186-c(PH-40-3461-59), $126,836.

Conoga Division, Underwood Corp., Van Nuys, Calif., fabricate and furnish six automatic frequency control (AFC) modification kits for AN/APS-38 radar set, NOas 59-6140-c(AV-31-2892-59), $80,682.

Research Division, Aeronca Manufacturing Corp., Baltimore, Md., 10 automatic data loggers for missile tactical telemetry, NOas 59-4180-(AV-31-2927-59), $26,809.

Arinc Research Corp., Washington, D. C., a study to determine the capabilities projected military and commercial requirements and industrial capabilities for complex electronic circuit packages and severe environment receiving tubes, NOas 59-4180-c(IF-43-4405-59), $79,922.

Pan American World Airways, Inc., New York, services and materials necessary for the orderly transition from government to contractor operation of the furnishing of en route aircraft support for government designated transient transport aircraft, NOas 59-4339-c(SF-30-3296-59), $73,090.

Aircraft Radio Corp., Boonton, N. J., 391 AN/ARC-59 transceiver equipment each consisting of one R7-427/ARC-59 receiver MT-605A/APR-9 mounting C-2241/ARC-59 control furnished in accordance with specification MIL-R-18500(Aer), NOas 59-6249-f (FD-31-1709-59), $607,537.

New Jersey Division, Kelsey Hayes Co., Clark, N. J., materials and services necessary to disconnect, prepare for shipment re-

move and load on rail cars or over the road trailers, machine tools and equipment. NOas 59-0024 r(IP-33-4411-53). $120,000.

Columbus Division, North American Aviation, Inc., Columbus, Ohio, 66 airplanes, model T2J-1 in accordance with detail specification SD-324-1 (16), letter contract NOas 59-0163(FC-32-1977-59). $19,350,000.

The Transport Company of Texas, Corpus Christi, Tex., services and materials necessary to furnish logistic support to government installations on Kwajalein Island. NOas 58-4170 r(SE-31-3888-58). $2o,000.

AVIATION SUPPLY OFFICE, 700 Robbins Avenue, Philadelphia 11, Pa.

Lear, Inc., Grand Rapids, Mich., synchronizers for automatic directional indicators on HSS-1-AN aircraft. N383-59368A (383/211457/59). 95 ea., $32,148.

Pinkins Inc., New York, suspension kits containing: back pad, parachute harness N383(MIS)20106A(IFB-383-480-59). 2,000 ea., $14,440.

Saunc Corp., El Segundo, Calif., parts kits to support aviation jacks, ground servicing equipment. N383-59769A(383/281278/59). $7,117.

AiResearch Manufacturing Corp. of Arizona Division, the Garrett Corp., Phoenix, Ariz., starters air turbine to support F11F aircraft. N383-59337A(IFB-383-074-59). 59 ea., $110,761.

Sperry Gyroscope Co. Division, Great Neck, N. Y., amplifier and generator assemblies to support engine analyzers. N383-59862A(383/282830/59). $85,430.

Purolator Filter Division, Bendix Aviation Corp., Royal Oak, Mich., filter element assemblies, to support fuel systems on F4D-1 aircraft. N383-58928A(383/211486/59). 3,070 ea., $17,585.

Hazard Wire Rope Division, American Chain & Cable Co., Inc., Wilkes-Barre, Pa., hoists for launching F4D-1 aircraft. N383-58741A(383/282161/59). 990 ea., $53,238.

Pigou Engineering, Inc., Pigou, Ohio, grip assemblies to support F14 aircraft. N383-58899A(383/214328/59). 212 ea., $35,913.

Henry Spra & Co., Inc., Brooklyn, N. Y., valve and hose assemblies to support regulators on oxygen and nitrogen trailers. N383-59784A(383/281246/59). $65,258.

Gasmand Engineering Laboratory, Inc., Middletown, Conn., clutches to support radar equipment. N383-58320A(383/233495/59). 52 ea., $44,148.

Leland Airborne Products Division, American Meehler & Foundry Co., Vandalia, Ohio, inverters, to support electrical systems in T2V-1, F11F-1 aircraft. N383-58380A(383/234711/59). 47 ea., $29,265.

Aeronautical Division, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., amplifiers, liquid oxygen, for various aircraft. N383-58809A(383/210888/59). 190 ea., $38,200.

AC Spark Plug Division, General Motors Corp., Milwaukee, Wis., levers and springs to support turbosupercharger regulators for AD-7 aircraft. N383-58988A(383/213113/59). $35,777.

Model Engineering & Manufacturing, Inc., Huntington, Ind., signal generators to support various aircraft and missiles. N383(MIS)-59546A(MIFR 33-684-5-ITC-0122) 304 ea., $153,000.

General Electric Co., Philadelphia, Pa., relays, 2 amp., 4 pole, double throw, sealed, panel mounting. N383-59537A(IFB-383-808-58). 9,320 ea., $40,884.

M. Stephen & Co., Inc., New York, parachute assemblies, personnel, chest type. N383-59787A(IFB-383-795-58). $311,877.

Frigen, Inc., San Leandro, Calif., drill-meters, electrically driven gyro stabilized for WV-2 and -3 aircraft. N383(17-383)-59418A(FRIFEN 11-2351/59-383/218369 59) 127 ea., $382,588.

Grimes Manufacturing Co., Urbana, Ohio, anti-collision beacons, to support various aircraft. N383-58083A(383/235504/59). 333 ea., $54,240.

Rubber Fabricators, Inc., Grantsville, W. Va., life preservers, yoke CO- inflatable with pouch, N383(213)-58151A(219/7001/58). 5,400 ea., $118,683.

The Goodyear Tire and Rubber Co., Akron, Ohio, brake linings to support brake assemblies on various aircraft. N383-59834A (383/211426/59), 58,272 ea., $58,533.

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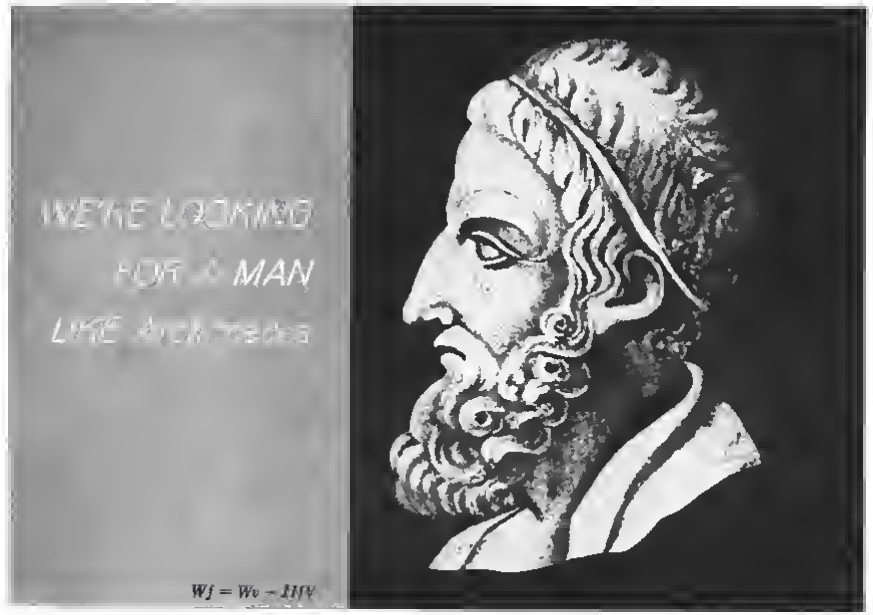

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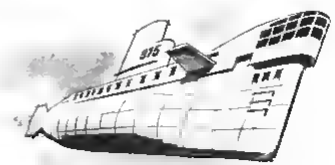

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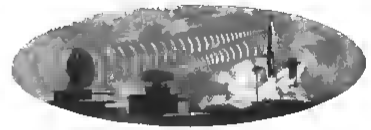

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AVIATION WEEK, AUGUST 10, 1959

LETTERS

Jet Age Safety

Mr Maier (AW June 29 p 98) and all other airline passengers have cause to question their safety in the jet age As an ex military airline pilot I feel reasonably well qualified to answer Mr Maier's question as to whether ex military pilots with airline transition training would provide safer jet airline operation than existing airline pilots The answer must be an emphatic no I believe most airline pilots with my background will agree with me that the military services are excellent training schools for the airlines but several years of actual airline flying are necessary to provide a pilot with the knowledge and proficiency to confidently carry millions of passengers safely over our nation's airways

However this does not mean that there is no room for improvement in the safety of present day jet operations.

The inception of the Federal Aviation Agency was watched with keen interest and anticipation by all persons concerned with air travel Here at last, it was hoped is an agency which will do everything possible to preclude the tragic but often avoidable accidents on our airways in the past To date it has failed miserably

With the power to provide regulatory measures which could enhance airline safety 100% its head Gen Quesada, has instead chosen to engage in querulous debates with the president of the Air Line Pilots Assn (AW June 29 p 79) the pettiness of which can only cause one to wonder how the leadership of two such great organizations fell into such childish hands

More specifically the Federal Aviation Agency has failed to

1 Require airborne radar to be in operation on all flights of four engine aircraft Radar has thoroughly proven itself as an indispensable tool to the pilot It is time he should not now be required to work without due to false economies on the part of some airlines

2 Settle the still smouldering pilot flight engineer controversy by specifying that the third man on the jet be pilot qualified Most engineers could meet this requirement while the "compromise solution" of carrying a superfluous third pilot plus an engineer is ridiculous

3 Make mandatory a retirement age of 55 for all jet flying While Boeing's Tex Johnston (AW June 29 p 32) is undoubtedly correct in his assertion that jet flying should be based on proficiency rather than seniority the only possible trend toward this at the present time (due to the strength of the pilots' seniority system) is to ground those pilots over 55 from flying jets Any airline pilot knows the deterioration in efficiency and reflexes which develop when a pilot passes 50 and certainly no pilot over 55 has any business flying high performance jet airliners

4 Require pilot proficiency checks to be given by an outside source—preferably FAA check pilots Company check rides are forgone conclusions How many company check pilots have the intestinal fortitude to give a final down check to a friend or neighbor pilot who can no longer "cut the mustard" Knowing the financial and mental distress which would ensue? To my knowledge no pilot has ever been discharged as the result of flunking company check rides The trouble is that all pilots just aren't that good and there are a few with each company who should have climbed out of the cockpit long ago Flight checks given by an unbiased outside agency would rapidly weed out these few

All these rules could and should have been written into CAR long ago—yet they are probably not even being contemplated today Conscientious pilots have fought this relaxed and complacent attitude for years Unfortunately, until this attitude changes you Mr Maier and the passengers riding with you are definitely not being provided the safety you need and deserve on your jet travels

AIRLINE PILOT
Los Angeles Calif

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

'Moments of Truth'

I was particularly pleased with your June 29 issue of AVIATION WEEK, as it contained a considerable amount of sweet reasonableness and many fine "moments of truth" First of all, let me establish that I am not exactly a disinterested party in the current cockpit dispute as I earn my living as an airline flight engineer Because of this it was especially encouraging to find that three separate and distinct representatives of aviation with interests quite dissimilar to my own have taken exception to the policies and attitude of ALPA President Clarence N Sayen

No less a luminary in the world of flying than Boeing's "Tex" Johnston expresses the opinion that his company's 707 can be operated with a three man crew "adequately and safely" and that the addition of a fourth man is of anything detrimental (p 32) Mr Johnston's interest is obvious public acceptance of the product of his company can only be acquired if it is operated safely efficiently and economically Boeing has for many years produced aircraft that have operated safely efficiently and economically with a crew consisting of two pilots and a flight engineer

National Airlines President George T Baker quotes impressive statistics of jet aircraft operation with a crew of two pilots and a flight engineer (p 33) Mr Baker also appears to be the first representative of management to have recognized the talent Mr Sayen possesses in the use of catch phrases slogans and euphemisms (My favorite slogan is "the fail safe concept," which never seems to be adequately defined by Mr Sayen.) Flight engineers were known as flight engineers all during World War II and as far back as the days of flying boats but now Mr Sayen prefers to replace that unity phrase with "third man" "third crew member" etc Mr Baker shrewdly recognizes the situation in its true perspective safety is not the criterion by which a third pilot would be added to the crew the third pilot is a wedge in the door through which ALPA will try to gobble up the flight engineers, thereby creating a monopoly in aviation second only to the teamsters in the field of transportation

Finally, Mr Sayen's negative and dictatorial attitude is recognized and promptly squelched by FAA head Gen Elwood Quesada a man of great stature whose significant contributions to aviation have been recognized and highlighted by a recent issue of a widely circulated national news magazine AVIATION WEEK has done us all a great service by publishing both the Quesada and the Sayen letters simultaneously (p 79) so that we can make comparisons on the characters of both men

It would appear from the rantings and ravings of Mr Sayen in his attempt to discredit the flight engineers that the average airline passenger could get the idea that every flight involves a constant battle, from pre-flight to post flight between the pilots and flight engineers The effect this would have on undermining his confidence in the crews flying the aircraft in which he is traveling is obvious However let me assure Mr Traveling Public that the vast majority of pilots and flight engineers get along harmoniously in a climate of mutual respect and admiration in the cockpits of the nation's airliners If any differences of opinion exist they are left in the outside when the cockpit door is slammed shut There is simply too much work and concentration involved in flying a large airliner from "A to "B" to allow petty differences of opinion to interfere

In my opinion, it is a pity that such an admirable group of men as the airline pilots should be represented by a person of the calibre of Mr Sayen

J F FENIMORE
Franklin Park, N J

Passenger Miles

On p 45 of the July 6 issue of AVIATION WEEK under the heading Shortlines appears the statement "American Airlines reports it reached 20 5 million revenue passenger miles on Friday June 19, the first time any airline has topped the 20 million mile per month mark." Aside from the obvious error in the next to last word may we point out with all due credit to AAL that Eastern Air Lines on Jan 5 1959 recorded 21 223 153 revenue passenger miles and on April 5 1959 had 20 463 259 revenue passenger miles Our records also show several other days on which we exceeded the 20 million mark.

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